ELP
OCTOBER 15, 1960

NEWS IN PERSPECTIVE

ECONOMIC CLIMATE

SEASONAL EXPANSION is starting to be fully felt throughout the economy. There is some question, however, as to whether the strength that is being shown will be able to overcome the major weakness—the employment situation. Here, growth has not kept pace with need, and rising employment has moved hand in hand with increasing unemployment. The labor force seems to be growing more rapidly than the number of job opportunities. So far, this problem has been held within bounds; in only a few areas has the rate of unemployment become oppressive.

CAPITAL SPENDING PLANS foreshadow stability. They are not as strong a spur to growth as had been anticipated. Spending for plant and equipment will run at a seasonally adjusted annual rate of about $37-billion in the year's last half. This is a hefty 10-percent above a year ago, but it is a decline of two percent from earlier plans. Over the full year, plant and equipment costing almost $36.4-billion will be added to the country's productive capacity, compared to $32.5-billion last year and $30.5-billion in 1958. Biggest increases will be made by makers of durables.

MANAGEMENT VIEW

MEETINGS ARE BIG BUSINESS, VP Howard Arnett of Portland GE reminded some 300 delegates to the annual meeting of NELPA last month. In his papers on "industry meetings," he argued effectively for their importance in disseminating information, exchanging ideas, stimulating thinking, developing policies, cementing relations. But, are there too many meetings?—Industrial leaders, like GE's Clarence H. Linder think so. He challenges technical societies particularly to reduce the frequency of meetings wherein much is duplicated—a practice which is "not the best answer to the serious problem of managing our fast-growing technology."

POWER: A POLITICAL ISSUE?—Central Survey's Pres. Wm. M. Longman doesn't think so. The public doesn't regard electric power as such, he told the Rocky Mt. Electrical League convention recently. Proof?—Many election results show that, on the same day, the same voters vote for and elect candidates with directly opposing views of this subject. (Safest and soundest management gesture in an election period would still seem to be in the get-out-the-vote realm. Here, companies—like Duquesne Light, via the force of Chairman Fleger's signature—urge serious preparation . . . and established eligibility.)

DOES SEC HAVE THE RIGHT to require a change in accounting classifications ordered by state regulatory commissions? AEP's Philip Sporn doesn't think so, calls recent SEC staff action to this end "an attempt to supersede state commission authority in an area where (it was) intended to have primary jurisdiction, and, what is more important, may, if successful, materially affect the rates of our electric customers." Mr. Sporn adds: "It is our firm belief that financial statements reflecting the accounting prescribed by state regulatory authorities . . . are most meaningful to investors and to the public." (AEP's strong argument for financing arrangements provided for in the present accounting practices: a record of no general rate increase for any System company in the last 30 years.")

POWER SYSTEM DUPLICATION, a 15-year-old problem in Tilamook County, Oregon, is to be solved finally—at a cost of $4.4-million to the Tilamook PUD! Voters of the District decided at a special election last month to authorize a bond issue in that amount for acquiring Pacific P. & L. lines in that area. For years, PP&L had been urging the public to decide on a resolution of the duplication. Whose "mistake" was the duplication?—Present management admitted it was the PUD's mistake—from the time management began building parallel lines, instead of moving to condemn Tilamook facilities of the then Mountain States Pwr. Co., which was merged into PP&L in 1954. (Loss to PP&L in the proposed sale: about 1.5-percent of the private utility's total electric revenues.)

CO-OP—PRIVATE POWER TIEUP is a good deal, asserts the co-ops of Minnesota. Eighteen of them plan to build a 200,000-kw plant, then have it integrated into Northern States Power's system through lease and operation by NSP. Say the co-ops of the Co-op Power Assoc.: "CPA will gain the advantage of reserve capacity of NSP's 1900-megawatt system, as well as the economies and efficiencies made possible by this single large unit." Target date for completing the $30-million REA-financed project is 1964.

SEMANTICS—IMAGE CHANGE, based on the national survey conducted for PIP, must be implemented by each utility company, or "the work (we do) will have little value," warns Pennsylvania P. & L. Co.'s Pres. Jack K. Busby. "On the national level, PIP is shaping its activities and materials to conform with the survey findings. We have reason to hope that other national organizations will do likewise." (Big, upcoming opportunity to show the industry's image dramatically: the New York 1964-'65 World's Fair, where the EEI will have the maximum space permissable to a single exhibitor—50,000 sq ft.)

WASHINGTON INFLUENCE

"ILLEGAL SALES" of public power to a private utility—charges by a report of a House subcommittee headed by Rep. Moss (D., Calif.)—has been called an instance of Democrats' "continuing efforts to promote Federal ownership in the utility field" by Republican Congressmen Barry (N. Y.) and Hoffman (Michigan). The majority found that Reclamation broke a Federal law in selling Central Valley power to Pacific Gas & Electric instead of to a preference customer. The report recommends construction of direct transmission lines instead of making wheeling agreements. Shasta Dam PUD would be the customer. The dissenters accused the majority of prejudging the matter, reaching "conclusions to fit its purpose." They find no "illegality" and note that Reclamation brief was ignored and that PG&E was not invited to testify even though an executive of the utility was present. The real purpose, say the minority, is to "obtain testimony as a basis for future crusades" to expand federal power facilities of all kinds. They conclude: "One would be hard put to find a more crass example of irresponsibility."

POWER ISSUE is being stressed by Democratic candidates Kennedy and Johnson. In Alaska, Kennedy decried the pace at which the Administration is studying the proposed Rampart Dam project and promised to speed work on "the greatest dam in the free world" to produce twice as much power as TVA. Comparing Administration attitudes toward water power unfavorably to Russia's, he asserted that "the tragic fact of the matter is that if Alaska still belonged to the Russians, Rampart Canyon Dam would be underway today."

In California, Kennedy called for reversal of "the defeatist policy of 'no new starts'" and moving ahead "with full development of our natural resources, including the extension of the Central Valley Project." He asked for reassertion of "the public's rights in the public domain which the so-called 'partnership' policy has undermined," maintenance of the preference clause, and getting on with "reclamation and basin-wide river development across the nation." Kennedy would also "appoint a Federal Power Commission that will uphold the public interest and not serve private interests alone."

NEWS IN PERSPECTIVE

Vice-Presidential Nominee Johnson has accused the Republican candidate of repudiating President Eisenhower by suggesting new starts on water projects. Johnson said Nixon had reversed his field "completely" after "consistently" supporting what he called the administration's "stand-pat position against new starts."

"NO NEW STARTS"—despite five new starts asked by the President and voted during the bob-tail Congressional session —is a campaign slogan used against the Administration by militant Democrats. Rep. Bowles (D., Conn.) made the accusation along with that of crippling rural electrification and "deliberately" raising interest rates. Rep. Pfost (D., Idaho) raised her voice and added the "giveaway" of Hells Canyon.

TAX PROPOSAL that would benefit utilities has been endorsed by the American Bar Association's tax experts. They approved adoption by the government of a "bracket-grouping" system for depreciation. This would permit taxpayers to select for depreciable property an appropriate useful life from a range, or bracket, of depreciation periods. This is comparable to the system now in use in Canada.

LOBBYING COST DEDUCTIBILITY question was not given favorable action by the American Bar Association's Committee on General Income Tax Problems. A proposal was made to permit deduction of costs incurred with initiatives and other submissions of questions to the electorate. This was objected to because it was not even as broad as the Boggs (D., La.) bill on the subject, which has already been favorably reported by the Ways and Means Committee. The Committee would not endorse the language of the Boggs Bill, so the question was reserved for further study.

ROLE AND PURPOSE of Congress' Joint Committee on Atomic Energy is being studied by George Washington University's National Law Center. Examination will be made of the committee's relationship with the judiciary, with executive agencies (including Defense and AEC), and with other Congressional agencies. Particular attention will be paid to "an analysis of the Joint Committee as an instrument of democratic government" during the year-long study.

BETTER REGULATORY PROCEDURE is being studied by a Conference on Administrative Procedure at the request of FPC and five other federal agencies. President Eisenhower has named Judge Elijah Prettyman chairman.

ROUND BUTTE hydro development has been authorized as part of Portland General Electric Co.'s existing downstream Pelton project on the Deschutes River.

A RED LIGHT for High Mountain Sheep, Pacific Northwest Power officials have told FPC, would mean a saving of $371-million in water power wasted to the sea. PNP said that cost of prime energy would be $293 per kw or $30 less than the rival Nez Perce plan sponsored by a group of PUDs. Benefit-to-cost ratio of High Mountain Sheep was set at 3.22 to 1 against 3.11 to 1 for Nez Perce.

INDUSTRY SIFTINGS

MOVE TO "POSITIVE SELLING" from price promotions, urges J. J. Anderson of Westinghouse, or the appliance industry's products may lose more of the consumer dollar than they have already. The marketing manager of the company's major appliance division offered this warning to the Rocky Mt. Electrical League at its recent fall conference.

PUBLIC OWNERSHIP IN OREGON was rejected for the second time in recent months, this time in Portland. The City Council last month decided it is impractical and not advantageous to exercise an option to buy the facilities of Pacific P. & L. Co.; moreover, to undertake such municipal ownership, the city would also need to buy out the Portland GE Co. as well. (Earlier this summer, the objective of establishing a state public power body was rejected by the Oregon AFL-CIO—see EL&P, Oct. 1, p 40.)

ELECTRICITY FROM A-POWER—It's a desirable goal, say 62-percent of the public, checked in a nationwide opinion survey conducted for GE. But, enough ignorance and confusion was found to prompt warnings (by Dr. Lyman Fink) that efforts to develop and apply atomic energy "could be blocked by a lack of understanding and acceptance" on the part of the general public.

A-POWER AT 14.4-MILLS/KWH could be expected from a 23,000-kw version of the first land-based design utilizing the gas-cooled reactor being developed for maritime application, according to a report delivered by General Atomic's Titus LeClair at the IAEA conference in Vienna last month. (See page 45 also.) Increasing the reactor's outlet temperature to 1500 F, along with some increase in plant size, he said, could sharply reduce this cost. General Atomic's Pres. Frederic de Hoffmann reported that General Dynamics HTGR plant permits sufficient extraction from the nuclear core to reduce the need for fuel re-cycling "to the point where reprocessing no longer dominated the fuel costs, and may be dispensed with at very little penalty."

"ACCUMULATED, DEFERRED INCOME TAXES" are not recognized as "operating expenses," the North Carolina Commission has ruled. In a rate increase bid P. S. of North Carolina claimed for federal income tax expense $105,000 more than it spent, sought to place the difference in an account to be included in operating expenses. The Commission ruled: "It will not require the utility's patrons to furnish funds not actually required as an expense . . . "

MORE PRODUCT DEVELOPMENT money in the 1960 budgets than in 1959—that's the story in nearly all industries, the AMA finds in checking some 400 corporations. Overall average increase is 10.7-percent, with electrical manufacturers (11) surveyed reporting an average 10.1-percent boost, while public utilities (3) are up 14.3-percent. However, the latter group earmarked only .2-percent for this activity in '59, where electrical manufacturers devoted 2.7-percent, reports AMA.

DRESDEN NUCLEAR STATION is being dedicated this week, well ahead of the target completion date of December set initially. The AEC's Chairman McCone, Ralph J. Cordiner, S. D. Bechtel and other top-name participants assembled at the Dresden site 50 miles southwest of Chicago to "launch" the nation's first full-scale, privately-financed nuclear powerplant.

HELPING THOUGHTFUL SHOPPERS by "defining the basic difference between electricity and other fuels" is the practiced aim of LBE, says the Program's policy committee chairman, Wm. M. Shepherd of Arkansas P. & L. Co. Appliance shoppers seem to welcome all the help they can get, he added. Newly announced help in projecting the "flameless" theme, notes Mr. Shepherd, is coming (via national advertising and promotion) from manufacturers like GE, Westinghouse, Hotpoint, Kelvinator, etc.

BETTER SCHOOL LIGHTING, defined scientifically for the first time in the standards based on U. of Ohio research findings, is being achieved in practice, with Kansas, "long known nationally for its outstanding school system, one of the first states to raise its official school lighting standards." (For information on a new guide for those interested in school lighting, write to the Kansas State Dept. of Public Education, Topeka. And, for another good source, the revised 250-page pocket-size "Lighting Handbook," write Westinghouse, Bloomfield, N. J., enclosing $3.00.)

UNDERGROUND H-BOMB POWER would seem to be low in cost, GE's VP Glenn B. Warren has observed. How would this power be harnessed?--"We would make a hole in the ground, 10,000-ft or so deep with a large cavern at the bottom, fill it up with water. Then we would drop a bomb into it, say every two or three weeks, and harness the steam that results from heat of explosion." Dr. Warren indicated that this method might be quicker and easier than continuous fusion processes now under investigation.

Key to Enterprise System: Preservation of Utilities

Arguments for the cause of priate ownership versus government wnership of electric power may ound tired and sometimes even unpalatable in some otherwise freenterprising parts of the U. S. But, hey *can* have a new and wholly onvincing ring just about anywhere, depending a lot on who says t . . . and how.

As summer ebbed, a variety of platforms offered occasions for the irm and resolute expressions of many about the importance of preerving private ownership in the power field. In brief summary, here are a few that must have won new ttention, both for the convictions nd the urgency of gaining wider ppreciation for them.

At Columbia University, 18 paricipants in a Utility Management Workshop drafted a statement callng Federal ownership of utilities a 'great danger to freedom and liberty."

Before a N. Y. Society of Security Analysts, the chairman of the Indiana P. S. Commission warned that 'the most fundamental problem facng privately owned utilities today s their preservation as an integral part of our free enterprise system."

At a new generating plant dedication in Minnesota, the president of Minnesota P. & L. Co. warned hat the trend toward getting the government into business is "getting serious in its effect on the investorowned utility industry today . . . and unless checked, it will be affectng all lines of business tomorrow."

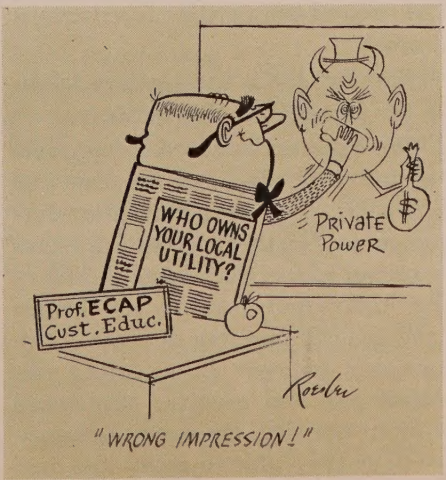
In the midst of a period of concentrated training for their own growing responsibilities of leadership in this industry, the Columbia Workshop participants agreed on this declaration of philosophy:

"It is our belief that this Industry, as perhaps no other, represents the dividing line between the socialization of economic enterprise into a government activity thus producing a monolithic, non-democratic state and the system of individual enterprise that most thinking people hold dear. It is believed that there is a constant ideological conflict between those who believe the contrary and wish to concentrate power in the state and thus escape responsibility. We believe that there is great danger to freedom and liberty in the latter and that our industry requires courageous and confident leadership for the future as well as competence."

Indiana Commission Chairman Robert S. Webb called to task regulatory commissions for "shortsighted policies which ultimately hurt consumers not only in respect to quality of service, but to long-range cost he will have to pay." He added: "A regulatory body which cuts rates to a bare minimum makes utilities much less attractive to the investor and imposes a burden on them in competing for investment funds, with the result that they must pay constantly more for their capital.

Commissioner Webb stressed the role of utility public relations in the preservation of private utility ownership. He observed: "The final outcome between the philosophies

(Continued on page 50)


WHO OWNS YOUR LOCAL UTILITY?
Private Power
Prof. ECAP Cust. Educ.
Roeder
"WRONG IMPRESSION!"

See National Impact in

California Cases Re Electric Vs. Gas Use

Two big questions—affecting the customer's "freedom of choice" between electric and gas appliances . . . and the seller's freedom to promote in influencing that choice—have been dealt with recently in cases which have been before the California Public Utilities Commission. Industrywide significance, obviously, could be attached to the determinations arrived at by this regulatory body.

The "customer choice" threat is now being opposed in a concerted effort of Sacramento Valley Electrical League members, who question the appropriateness of Commission decisions (effective since April 20 this year) setting up new rules affecting the line extension practices of all privately-owned gas and electric utilities operating in California.

The question of what is a "proper" level of appliance sales promotion expense was involved in applications before the California PUC for rate increases by the Southern California Gas Co. and Southern Counties Gas Co. Briefs referring to these applications had been filed —one protesting the sale of gas appliances by public utilities, and another urging the proposed appliance sales expenses of the Southern California Gas Co. be curtailed.

Much opposition to the proposed hikes was based on the question of whether utilities should engage in the sale of appliances, or should limit expenses allocated for this activity.

In its decision (60-PUC-145) granting rate increases to the two Southern California gas utilities, the Commission made clear its position on expenditures for advertising and sales promotion, which became one of the major issues in the long series of public hearings on the two applications. The Commission did *not* limit the amount which the utilities may spend on advertising . . . but for ratemaking purposes allowed as a chargeable expense to be paid by customers, less than the applicants had estimated would be necessary.

The California PUC pointed out that:

1. The Commission always has recognized the competitive need for advertising by utilities, even though customers have often protested that no advertising is necessary;

2. The Commission does not limit the amount which a utility may spend on advertising, but fixes as the amount of such advertising to be included as an expense of operation and paid for by rate payers, the amount it believes to be reasonable;

3. The Commission in the past has *raised* the amount to be spent for advertising by a regulated company when that was believed to be in the public interest.

A brief filed by the PUC staff counsel prior to the decision proposed a more realistic and reasonable promotional budget than that submitted by the Southern California Gas Company for its appliance sale activities.

Reasons for the PUC staff's proposed adjustment, cited in the brief, were to halt increasing divergence between sales promotional costs in the applicant's area and other areas in California; to remove from the rate payer a part of the burden from constantly expending costs of sales promotion, and to decrease expenses which normally should be paid by parties other than the applicant and, which, according to the brief, are of little value to the rate payer.

Decisions rendered earlier this year, affecting line extension practices, are of particular concern to the electrical industry because it seems certain in Northern California at least that a number of builders now installing domestic electric appliances in new homes will feel compelled to change to gas equipment, the Sacramento Valley Elect. League notes. Because of the California Commission's "overall stature," the League feels these recent determinations could well have an impact on the electrical industry in other states far removed from California.

Basically, the League questions whether the situation developing as a result of the rule changes is "conducive to equal opportunity to select gas or electrical appliances." On the contrary, the League contends, "comparative cost facts make it clear that much of Northern California is likely to see a lot more gas appliances sold unless the gas extension rules are changed."

The League notes that gas extension rules previously applicable in Northern California did not penalize either gas or electric appliances so that normal competitive forces were at work.

Here, briefly, is the position taken by the League on this matter:

"We have endeavored to appraise the practical effects of the new gas extension rules with particular reference to Northern California and it seems clear that large builders and individual owners no longer have the full freedom of choice they formerly enjoyed in selecting between gas and electric appliances without penalty. By every measure we have been able to apply, the new rules seem neither logical nor reasonable.

"The League and its members will continue efforts to sell the electric way of living and confidently expects that more and more people will go 100-percent all electric in their homes and business At the same time, it must be regarded as truly unfortunate when barriers beyond the market place impose handicaps on partial installations of domestic electric appliances The new handicaps on partial installations of domestic electric appliances make it certain that some Northern California builders who would install electric equipmen will now feel compelled to shift to gas and this is a matter of concern to the electrical industry in the area as a whole.

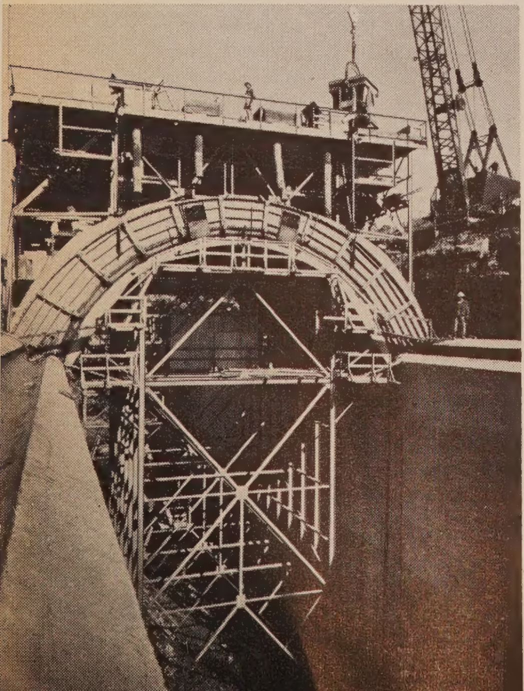
"This has already occurred in several instances in the League's territory. If the industry endeavored to save the business by making an offsetting cash payment to the builders the payment would simply be passed along to the gas utility. In turn, the gas utility might feel compelled to adopt defensive measures and a leap-frogging process would be on its way. Nobody wins in a situation of this nature and it is the individual customer or home purchaser who foots the bill. Elsewhere in most of Northern California, the serving utility is a combination company so the electric cash register has a lesser ring while the gas cash registe jingles louder.

"Manufacturers, distributors dealers, the serving electric utility electrical contractors and electricians—all are involved in this matter. In addition to any immediate losses in business, there are the longer term effects on the manufacture and installation of transformers, substations and generating capacity. Further, the happenings in this area may easily have implications for states far away from California.

"We recognize that both utilities and their customers need the protection of reasonable extension rules There is full justification for questioning the appropriateness of the new rules, however, when the end result becomes a competitiv weapon despite the Commission' desire that the rules not do so.

(Continued on page 50)

In one phase of the Niagara River Power Development at Niagara Falls, N. Y., mammoth water power conduits are being shaped into 3½-foot concrete thickness, using specially designed steel forms designed and fabricated by the Blaw-Knox Co. The underground conduits—22,600-ft long, 46-ft wide and 66-ft high—will divert water from the Niagara River, three miles above the Falls, into a mile-long open canal (or surge basin) leading to a still-to-be-completed reservoir and generating plant.



NUCLEAR NEWS

REACTOR TECHNOLOGY—A better understanding of it is the primary goal of U. S. research and development work in nuclear power, the AEC's U. S. Staebler told an IAEA conference on small and medium reactors in Vienna last month. He explained that this work has *not* been influenced primarily by interest in a particular range of plant capacities, and while work to date may be considered to be "somewhat oriented toward the expectation that U. S. nuclear power is most likely to become economically competitive in areas which can use plants with a capacity of 300,000-kwe, most of the work is equally applicable to much smaller plants."

ORGANIC-COOLED REACTORS were the subject of review earlier this month in an AEC-sponsored information forum in Los Angeles, where Atomics International was host. Conferees heard progress reports on several current and upcoming reactor projects, as well as the status of organic reactor research and development on coolant, fuel, heat transfer, etc. in the U. S. and Canada. Also discussed was the future organic reactor program of the Commission.

JAMESTOWN, N. Y. SITE for a small-sized pressurized water reactor was reported to have been turned down for the second time by the AEC's Advisory Committee on Reactor Safeguards, in spite of a proposed increase in the exclusion area, which was still not as large as the committee's suggested radius of 2,000-ft.

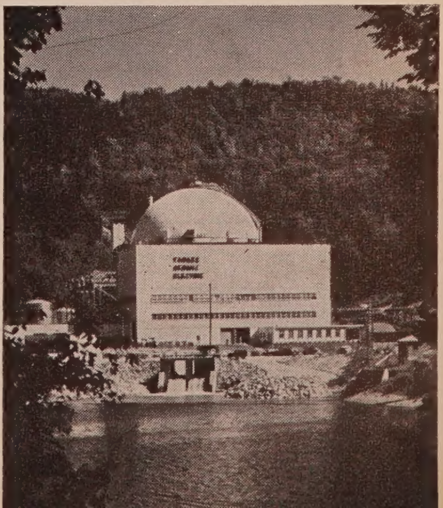
LOS ANGELES-PASADENA PROJECT incorporating the improved-cycle boiling water reactor involved withdrawal of a bid award to GE, after Allis-Chalmers was reported to have claimed that its rival bid on construction of the reactor was $1-million less than GE's.

EXPENDITURE OF REASONABLE SUMS to keep utility personnel adequately abreast of developments in nuclear powerplants will in all probability continue to win approval of state utilities commissions, a survey for the AEC reveals. A report of the study, "State Regulation and the Future of Nuclear Power," involving a questionnaire response from 37 state commissions, is available from the Dept. of Commerce, OTS, Wash. 25, D. C. The view of the typical state commission—recognizing such expenditures for rate-making purposes—remains unchanged from the time the state commissions were surveyed on this subject by EL&P in 1957 (See EL&P, Sept. 1, 1957).

DIRECT CONVERSION TESTS reported from the California facilities of North American Aviation's Atomics International Division and from General Dynamic's General Atomic Division involved, respectively, a thermo-electric and a thermionic conversion device. Atomics International's tested an experimental nuclear core weighing less than 200-pounds, with no electricity generated. General Atomic's produced 90-watts of electric power from the heat of fission in a cesium cell thermionic converter (overall efficiencies as high as 10-percent at an operating temperature of about 3500-F). Space power applications are the aim of both test series, though the utilities in the Rocky Mountain-Pacific Nuclear Research Group supports the General Atomic project.

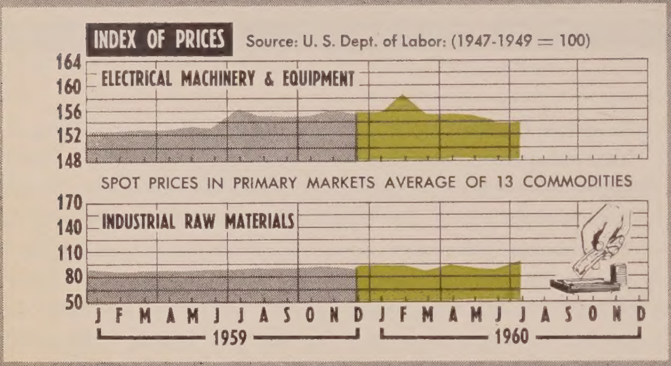
A CHEMICAL PROCESSING PLANT for spent nuclear fuels, studied by Davison Chemical and Bechtel for feasibility of construction and operation with private funds, appears to be less than promising for early action. Utility members of the Industrial Processing Group to which Davison reported in July were expected to reach a decision on the project this Fall, but indications are they are in no hurry to move. Questions involved include: what amounts of material are to become available in next few years, how would such a project be financed and what would customers be charged for their respective demands in the proposed facilities—all tough answers to find at this stage.

RECENT AEC REPORTS TO CHECK—In the Commission's four-part study of the Civilian Power Reactor Program, Part III, Status Reports Book 2—Pressurized Water Reactors-TID-8518 (2); Book 4—Heavy Water Moderated Reactors-TID-8518 (4); and Book 6—Sodium Graphite Reactors-TID-8515 (6). Also, Volume 1, Materials, first of the revised and enlarged second edition of the "Reactor Handbook" ($36.50 a copy, from Interscience Publishers, Inc., 250 Fifth Ave., NYC.). Also, "State Regulation and the Future of Nuclear Power," (TID-8208), for 50-cents from Dept. of Comm., OTS. Also, "Selected Reactors of the Power Reactor Demonstration Program" (TID-3556), for 75-cents, also from Dept. of Comm., OTS.



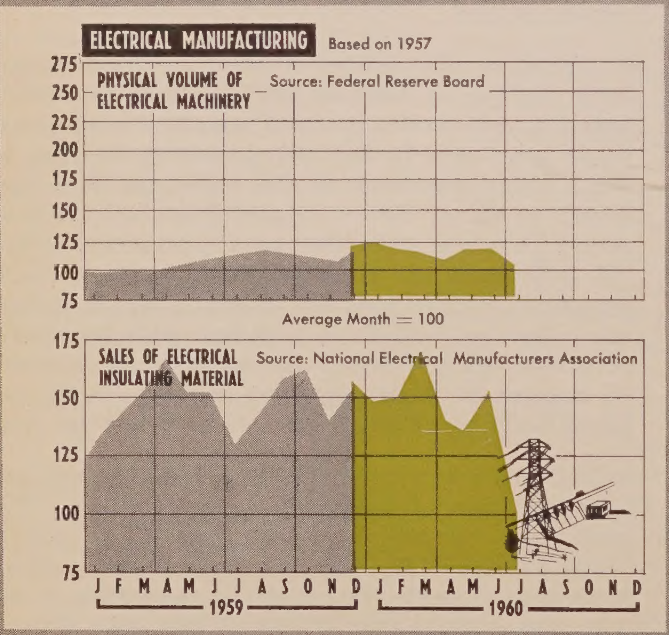
First in New England, Yankee reactor at Rowe, Mass. has been operating since mid-August. Participating in the project are: New England Elect. System, Conn. L. & P. Co., Boston Edison, Central Maine Pwr. Co., Hartford Elect. Light Co., Western Mass. Elect. Co., P.S. of New Hampshire, Eastern Utilities Associates, New Eng. Gas & Elect. Assoc. and Central Vt. P.S.

MARKETING GUIDEPOSTS



INDEX OF PRICES Source: U. S. Dept. of Labor: (1947-1949 = 100)

SPOT PRICES IN PRIMARY MARKETS AVERAGE OF 13 COMMODITIES

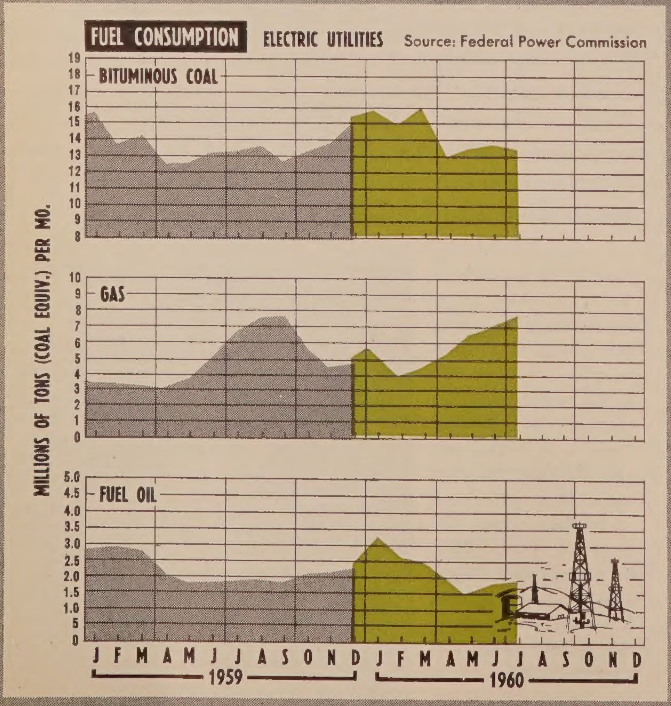


ELECTRICAL MANUFACTURING Based on 1957

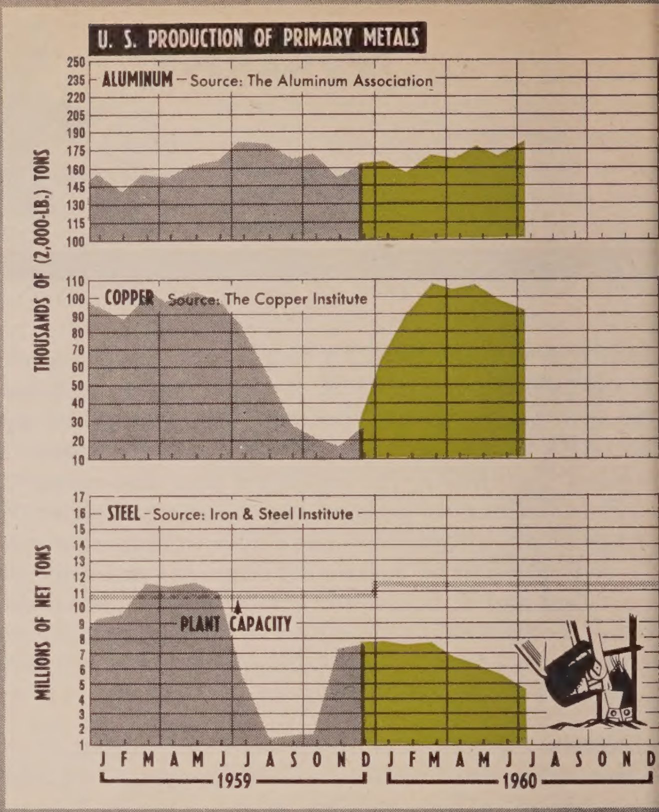
PHYSICAL VOLUME OF ELECTRICAL MACHINERY Source: Federal Reserve Board

Average Month = 100

SALES OF ELECTRICAL INSULATING MATERIAL Source: National Electrical Manufacturers Association



FUEL CONSUMPTION ELECTRIC UTILITIES Source: Federal Power Commission

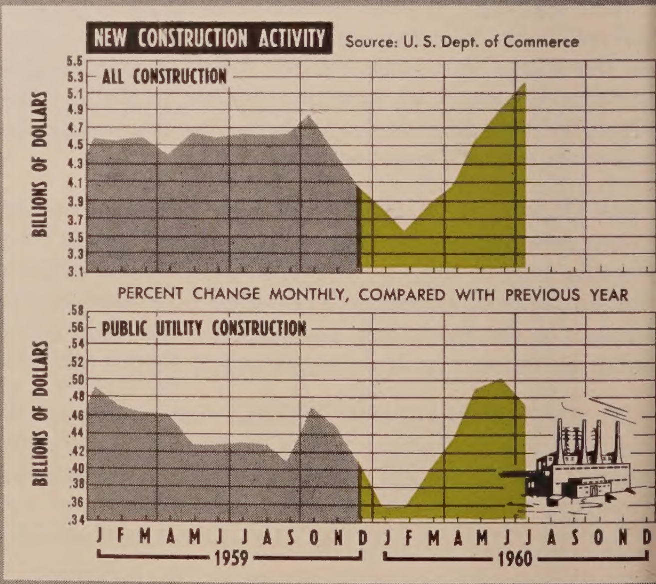


U. S. PRODUCTION OF PRIMARY METALS

ALUMINUM — Source: The Aluminum Association

COPPER Source: The Copper Institute

STEEL — Source: Iron & Steel Institute

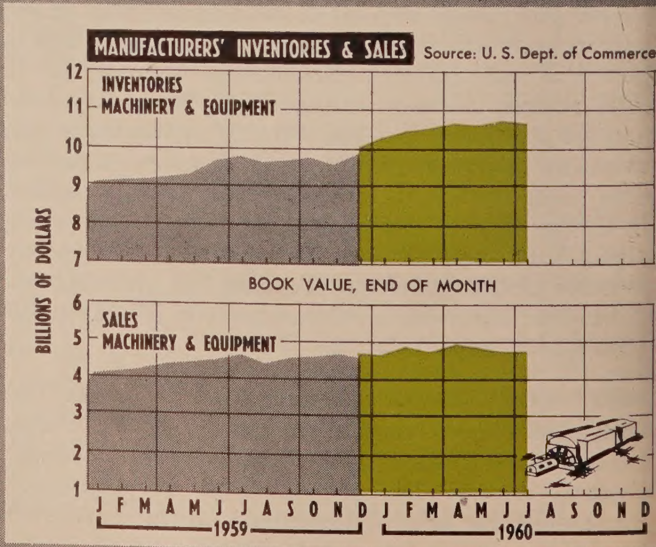


NEW CONSTRUCTION ACTIVITY Source: U. S. Dept. of Commerce

ALL CONSTRUCTION

PERCENT CHANGE MONTHLY, COMPARED WITH PREVIOUS YEAR

PUBLIC UTILITY CONSTRUCTION



MANUFACTURERS' INVENTORIES & SALES Source: U. S. Dept. of Commerce

INVENTORIES MACHINERY & EQUIPMENT

BOOK VALUE, END OF MONTH

SALES MACHINERY & EQUIPMENT

Public Service Electric and Gas Rate Increase

Company's request for $47.5 million reduced to $10 million.

Commission allows a 6.25% rate of return as against 6.5% requested by Company.

Commission grants year and original cost rate base plus working capital. Fair value findings denied.

The Commission's allowable rate of return was considerably closer to the amount requested by the Company than to either of the two intervenors. In this instance, the Rate Counsel stated that 5.81% was a fair return while the G.S.A. stated that the Company should be allowed to earn 5.64%.

The Commission noted that while the Company's witness overstated his case in requesting a return of 6.5% by the same token the testimony of the opposition witnesses: " . . . does not fully give consideration to all factors."

The Board's order went on to say that:

" . . . some recognition should be given to the factor of attrition. The Petitioner's plant and facilities are continuously expanding, rate making is prospective and prices have continued to rise. In this proceeding we will give recognition to these factors in our determination of a fair rate of return."

The Order of the Board, wherein it deals with the determination of the rate base, makes interesting reading. The rate bases presented by the Company varied from $1,025,000,000 for average net original cost to $1,725,000,000 end of year trended original cost. The Company also made a finding of fair value with a rate base of $1,260,000,000.

The G.S.A. presented evidence purporting to show a year end rate base for 1959 of $987,000,000, with an average rate base for that year of $939,000,000.

The Order of the Board went on to say that:

"Petitioner has included in its claimed rate base amounts for unamortized gas conversion costs, gas plant acquisition adjustments, unamortized abandonment cost of Camden Coke plant, plus a claimed allowance for working capital. In addition to the usual deductions for book depreciation reserve and contributions and advances in aid of construction, the Petitioner has given effect to the elimination of the Camden Coke plant.

"Rate Counsel accepts in substance the Petitioner's original cost and the unamortized gas conversion costs, but would make a lower allowance for working capital and handle the abandonment of the Camden Coke plant on a different basis. They would not include the gas plant acquisition adjustments. Rate Counsel would also deduct from rate base the restricted surplus resulting from taxes deferred by amortization of emergency facilities. Rate Counsel would adjust book reserve by computing the depreciation reserve on a straight-line basis.

"GSA also accepts in substance the Petitioner's original cost and would make a lower allowance for working capital. They would make no allowance for unamortized conversion costs, gas plant acquisition adjustment and the unamortized abandonment loss on the Camden Coke plant. They would deduct property held for future use and in addition, property (including transformers, meters and services) which they contend are not presently in use, as well as the restricted surplus arising from both taxes deferred by amortization of emergency facilities and accelerated depreciation.

"The Petitioner also presented evidence of trended original cost.

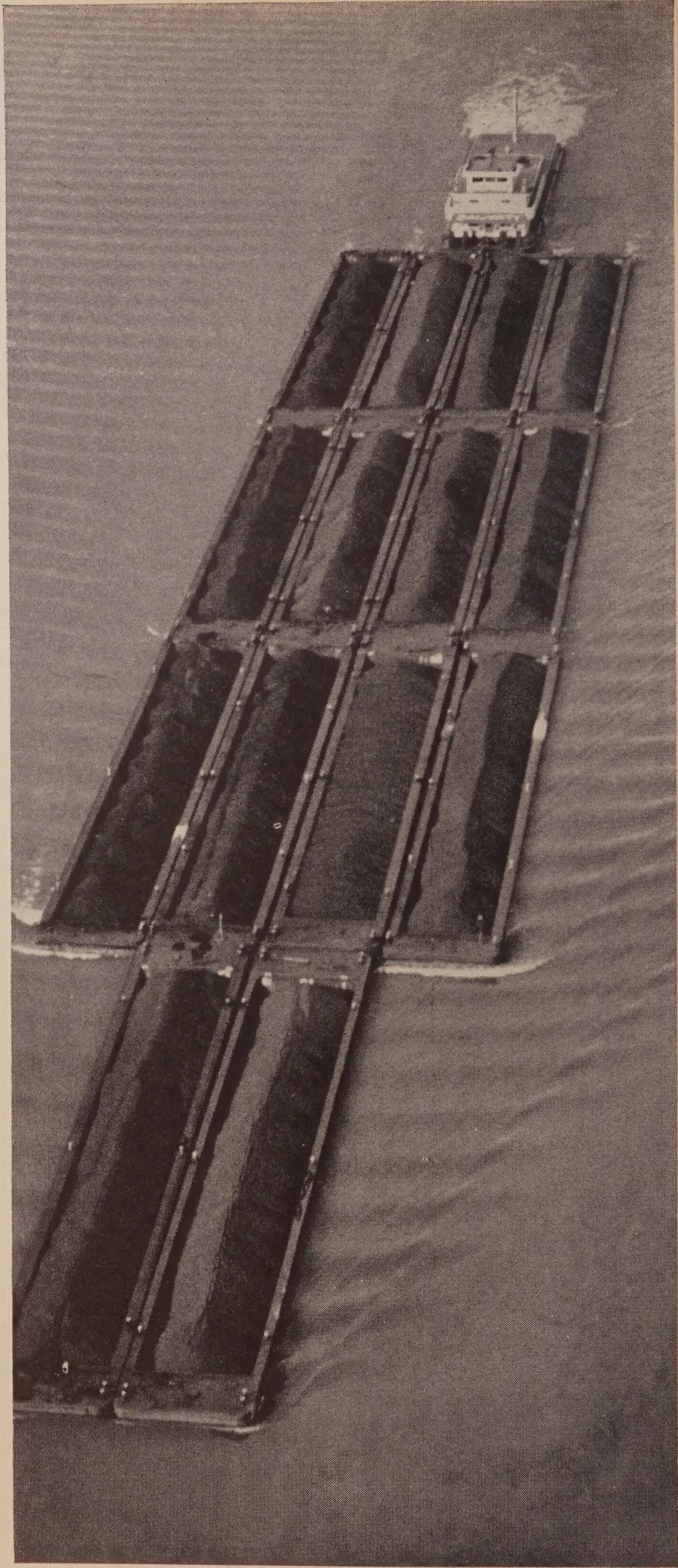
In denying the Company's plea for a fair value finding of the rate base, the Board had this to say:

"The Board does not consider it necessary here to set out in detail the many weaknesses or infirmities presented in the Petitioner's trended original cost study and as developed by extensive cross-examination. Suffice it to say that this study is not dissimilar to a cost of reproduction study and subject to a number of the same defects that the Board has heretofore pointed out in other decisions relating to this subject.

"Since the Petitioner's claim for fair value is in large part based on the trended original cost study the same weaknesses and infirmities would be reflected.

"In the light of the record in this proceeding the Board deems it reasonable, proper and fair to both customers and the Petitioner to develop its findings as to rate base on evidence pertaining to historical cost at the end of the year 1959."

It is of interest to note that the Board's finding of $1,069,000,000 as the rate base is only $11,500,000 less than the Company's year end depreciated original cost rate base. In this connection, it should be noted that the fair value finding of $1,260,000,000 is not far removed from the figure of gross utility plant in service, which at the end of 1959 amounted to $1,272,000,000. It is also significant that the Board denied the Company a six-month forward rate base which it had granted several years ago to the New Jersey Bell Telephone Company. Presumably, the legal arguments which followed that case were such as to make the Commission decide that it was best to "let sleeping dogs lie."



how does 1970 look... from here?

(and how about 1980?)

The most look-ahead industry in the nation is undoubtedly the electric utilities. Glance back over the past 10 years and the reason is obvious. And with even greater electric needs forecast for the next 10 and 20 years, it's not surprising that any remaining short-term thinking about the way to buy *coal* is giving way rapidly to the same *long look ahead.*

There is increasing awareness that behind an attractive invoice price can be the hidden incremental costs of excessive coal handling, ash handling, equipment outages, freight charges on inerts, operating inefficiencies of many kinds.

There is increasing interest in quality coal that delivers *steam* at the lowest *net* cost. There is increasing interest in adequate reserves, in uniformity of supply, in suppliers in a position to deliver the right kind of coal on a reassuring long-term contract basis.

An increasing number of utilities are looking to Island Creek as a supplier of such coal . . . and such reassurance. We'd welcome a chance to discuss this matter more specifically with you. Write, wire or phone.

You can depend on Island Creek
. . . a career company dedicated to coal

ISLAND CREEK Precisioneered Coals

ISLAND CREEK COAL SALES COMPANY, Chafin Building, Huntington 18, West Virginia • Chicago • Cincinnati • Cleveland • Detroit • Greensboro • New York • Pittsburgh

WASHINGTON OUTLOOK

by **RALPH ELLIOTT**
Washington Editor

A Matter of Fair Play

The Federal Power Commission has ruled—finally and definitively—that the cost of electric utility company advertising which the Commission says is "political in character" may not be treated as an operating expense, but must be accounted for "below the line" as an income deduction.

No surprise was occasioned by the recent decision. Specifically, it dealt with eight ads in the 1957 series of the Electric Companies Advertising Program, and the bookkeeping of the 76 utilities who paid for them. It was the expected, routine wrapping up of the controversy at the administrative level, for the Commission had tipped its hand over a year ago in an interim ruling rejecting the companies' evidence that the ad costs were both necessary and reasonable business expenses. The utilities were told then that they would be limited to a possible showing that the ads were non-political. Yet, in the next breath, they were as much as told that the Commission had already decided the ads were political.

Consequently, the final decision lacked punch as a news item, and understandably received only casual and sketchy treatment in the press.

But the decision has a clearly threatening significance that doesn't show up in its fifteen pages of legal reasoning. It stands as a disheartening example of rigid adherence to an administrative regulation (the very applicability of which is open to question in the case), and the brushing aside on purely technical grounds of the inescapable and overriding issue of fair play.

It stands, too, as an ominous victory for the Socialist-planning advocates of government power. For FPC's insistence on a narrow interpretation of its accounting regulation in the ECAP case is closely analogous to the ruling of the Internal Revenue Service that the cost of "political" ECAP ads is not deductible as a business expense for federal income tax purposes. It is no mere coincidence that both cases were instigated by ardent promoters of government power: the IRS case by TVA's top champion, Senator Kefauver; the FPC matter by Clyde Ellis, general manager of the National Rural Electric Cooperative Association, whose fingers are in just about every phase of the public ownership movement. The obvious purpose of their complaints lodged with the two agencies was to deter the utilities' efforts to bring into the open the dangers and inequities that run hand-in-hand with government competition with private enterprise.

FPC's opinion disposing of the ECAP matter was a carefully circumscribed document. It held that the Commission's Uniform System of Accounts prohibits expensing of the cost of advertisements "political in character;" that "it is clear from their face" the ECAP ads "involve the presentation of argument in matters of political controversy"—period. The Commission was not interested in the companies' pressing business need for carrying out self-defense advertising; or their obligation to customers, shareholders and employees to meet the competition of government power through the normal means of advertising; or whether the costs were ordinary, just and reasonable business expenses.

This case, the Commission insisted, "presents only a question of proper accounting . . . no consequential interference with management can result from these accounting classification proceedings, but only from rate proceedings . . ." It would be senseless to expect, however, that the accounting decision forcing the ad expenditures below the line would not be decisive in any later rate proceeding involving an ECAP contributor.

It is interesting that none of the ads in question proposed any specific action at the polls, or through public officials. Their message was confined to pointing out the tax inequalities as between government and investor-owned power systems, and the unfair discrimination resulting from favoritism to consumers served by the government systems. But FPC read into the ads various "ultimate purposes," such as the influencing of public opinion in matters that are "directly political."

Undoubtedly, had the ads been directed at strengthening the companies' competitive position in relation to other privately owned sellers of energy, there would have been no question as to the propriety of classifying the cost as a business expense. In other words, the expenditures were in all respects reasonable and necessary from an ordinary business viewpoint, except for the fact that the arch-competitor who made the ads necessary happened to be the government.

An oft-repeated argument holds that the IRS and FPC rulings deprive the ECAP contributors of no fundamental rights, since the rulings do not prohibit the advertising but merely provide that stockholders, rather than customers, foot the bill. That argument conveniently overlooks a vital, and what should be the controlling, principle. If the utilities are justified in expensing the cost of advertising to meet private competition, then surely they are far more justified in so treating the cost of meeting taxpayer-subsidized competition from their own government, whose power agencies often use both taxpayer and rate-payer money to publicize their side of the story.

So, stripped of fancy technicalities, what has happened in the case of ECAP is a sheer denial of fair play. It is doubtful that the courts will correct the situation. Perhaps some day Congress will.

Ownership—*from p. 43*

of government ownership and private ownership will be in direct ratio to the efforts put forth in the utilities' public relations program aimed at preserving that private ownership."

Fortunately, of course, the kind of regulatory climate in which a utility can grow strong and plan with confidence in the future is not uncommon. An exemplary one, according to Chairman Elmer L. Lindseth of the Cleveland Electric Illuminating Co., is Ohio's. In a recent newspaper story (in the "Christian Science Monitor"), Mr. Lindseth acknowledged that Ohio's 47-year-old regulatory formula "has encouraged utility management to plan and build for the long run, by permitting earnings which justify the assumption of the risks that go with expansion and improvement."

Among results of Ohio's "sound, progressive regulatory philosophy," Mr. Lindseth says, are low utility rates, outstanding industrial growth, and the fact that Ohio annually consumes more electric power than any other state, though fifth in population and 35th in area.

The Ohio formula—often praised for its results but sometimes criticized in theory—fixes a utility's rate base as of a certain date and also fixes a fair rate of return on the base, Mr. Lindseth explains. To do this, he states, the state evaluates the utility's plan and property according to its current value, in terms of today's dollar—thus making allowances for inflation.

This regulatory climate has resulted in a readily available supply of low-cost capital when Ohio utility securities are offered to the public, Mr. Lindseth points out.

Other results have been an enviable record of new industry and, for the state's residents, a monthly utilities bill that averages $25.14 in the state's largest cities—27 percent lower than the average for the 25 largest cities in seven surrounding states.

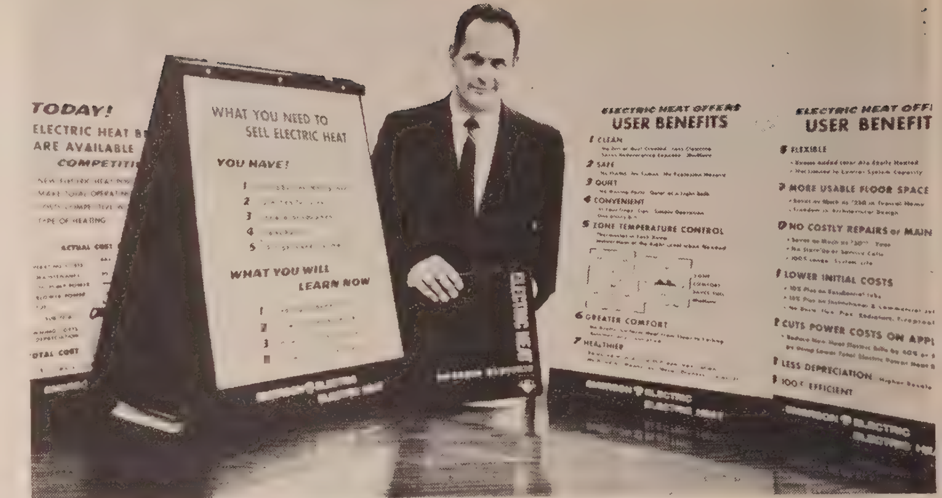
Minnesota P. & L. Co.'s Pres. Clay C. Boswell noted in his recent dedication remarks that voters should keep in mind when casting their ballots that government in the power business is characteristic of a socialist economy. "If we want to preserve the system under which this country has been so successful," he warned, "then we had better begin doing something about it."

Such a "grandiose scheme" as he used for illustration was TVA.

But, "government" keeps getting into the power business in a somewhat less grandiose, if not less conspicuous way. One such "scheme" was the REA-financed generating plant and transmission system being proposed by the South Mississippi Elect. Power Association. And, the president of the Mississippi Power Co., A. J. Watson, Jr., spoke out against the scheme this way:

"For many months before the request of South Mississippi EPA for authority to build the $16,000,000 in new facilities, we offered to continue to furnish electric service to all the co-operatives we serve at existing rates which are far below those proposed by South Mississippi. We continue our offer to serve these Associations at the same rates and on the same terms.

"We do not think that these tax exempt facilities which would initially cost in excess of $16,000,000 and which South Mississippi EPA says in its petition will be greatly increased in the near future should be constructed replacing fully taxed facilities of the company, when the company is offering to continue providing service to these associations at less cost."


TODAY!
ELECTRIC HEAT
ARE AVAILABLE
WHAT YOU NEED TO SELL ELECTRIC HEAT
YOU HAVE!
WHAT YOU WILL LEARN NOW
ELECTRIC HEAT OFFERS USER BENEFITS
ELECTRIC HEAT OFFERS USER BENEFIT

Filling a widespread need in the electric heating field, a new "installer training program" is being introduced for electrical contractors and others by Emerson Electric this month. Designed for Emerson sponsorship in cooperation with local electric utilities, the comprehensive compact training course can be given in one three-hour session. Above, the assistant to Emerson's president, W. C. Nusbaum, demonstrates main components of the training program.

California—*from p. 44*

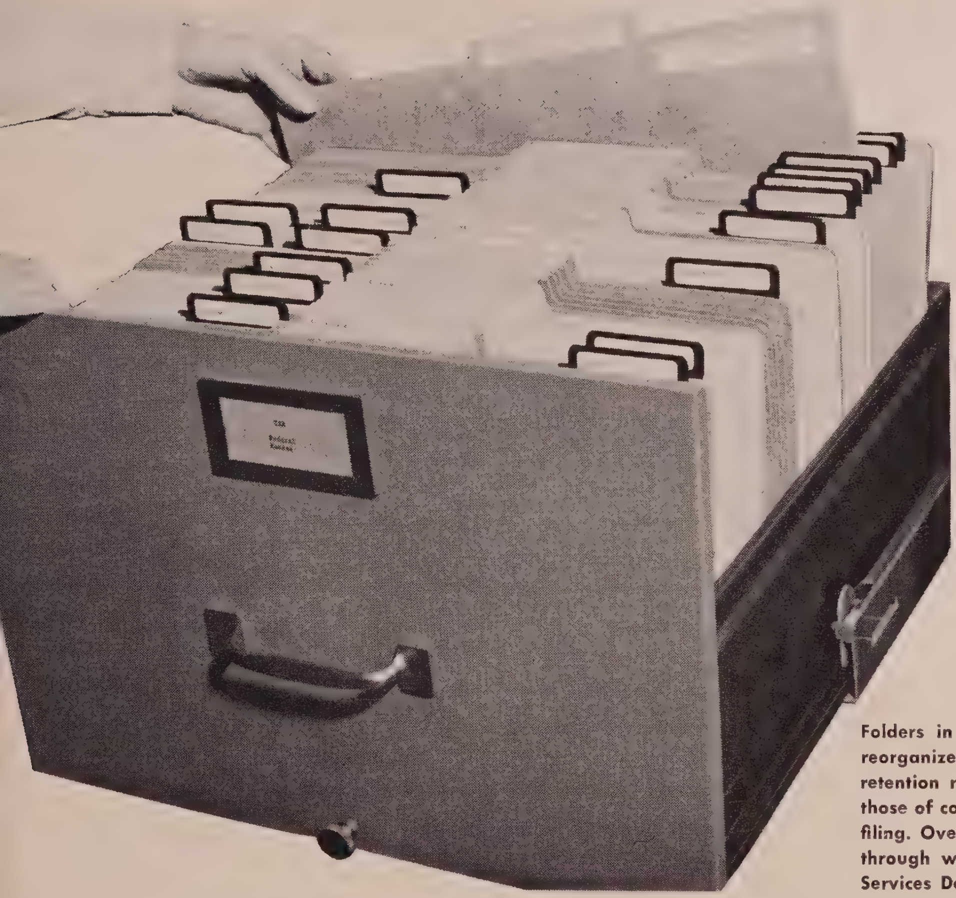
"The League strongly believes that the gas main and service extension rules formerly in effect achieved the desires of the Commission on the competitive aspects. Some revisions may have been in order but certainly not to the extent reflected in the new rules.

"We further believe that this is a matter affecting the public interest because the net effect will be to increase home building costs which must ultimately be paid by purchasers of the homes."

What is the League's proposed "course of action?" The League points out the Commission can reopen this matter on its own motion, or the initiative can be taken by the Pacific Gas & Elect. Co. by filing a petition for a rehearing. The presidents of both organizations (Everett C. McKeague and Norman R. Sutherland) have both been asked to "take prompt action leading to a revision of the new extension rules." Also, builders and other members of the electrical industry have been urged to evaluate this situation in terms of their own operations.

(Editor's Note: In late September, it was reported, other opposition to the revised gas extension rules had not formed in California; and PG&E indicated it was not planning a rehearing petition.)

A 79-year accumulation of records, filling the better part of a nine-story warehouse, was too much to fit into KCP&L's new one-story warehouse building. Complete record system revision was necessary to solve the problem . . . and eliminate 75 percent of the accumulation.



By E. G. FREISINGER,
Superintendent of Reports and General Records,
Controller's Office,
Kansas City Power & Light Company

Folders in subject file of the accounting department as reorganized show not only title and classification, but also retention requirements of Federal Power Commission and those of company policy. Cross indexes help in finding and filing. Overhaul of filing system was planned and carried through with consultation of a Remington Rand Business Services Department specialist.

REVAMPED SYSTEM ELIMINATES 100 TONS OF RECORDS AT KCP&L

WHEN a utility company has been in business for 79 years, the accumulation of office records can reach staggering proportions. Since it was founded in 1881, Kansas City Power & Light Co. had filed and saved virtually every corporate or accounting record. There was not much urgency to cut down or weed out this growing store of records as long as a large nine-story warehouse offered plenty of space at low cost. But two years ago a decision was made to abandon this old structure in favor of a one-story building. After a look, we knew we had a big job to cut down our records to manageable size.

As an interstate utility, KCP&L comes under jurisdiction of three regulatory bodies—the Federal Power Commission, the Missouri Public Service Commission, and the Kansas Corporation Commission. In addition to our own company records, there were all those from predecessor and acquired companies. And while regulatory bodies permit destruction of a substantial number of old records, we had failed to exercise this privilege.

Procedure called forth by the problem was to conduct a complete inventory of the old records; to reduce drastically their bulk; and to establish a new company retention policy to prevent large and unnecessary accumulations in the future.

To secure professional advice and supervision, KCP&L called in records specialists from the Business Services Department, Remington Rand Co. Finally, to carry out the job we had a group made up of one Remington Rand specialist, one KCP&L employee who had been keeping the historical records, a temporary employee for the heavier work, and the writer, devoting such time as he could.

The company legal department established that certain categories of documents need be kept only 10 years, and this ultimately led to the destruction of about 100 tons of old documents.

Much of this was in the form of disbursement vouchers stored in 2439 filing cabinets. A new retention schedule provides that the bulk of these vouchers in the future will be kept only 10 years.

A complete review of everything in the files permitted us to destroy at least 75 percent of the accumulation. Other categories of documents were set up on schedules similar to that of the vouchers. Schedules call either for permanent retention or for automatic destruction after varying periods of time.

In the active accounting department records, two basic categories were involved—contracts and subject files. We found about 7000 contracts in the files, but no method for determining if and when any contracts had been terminated. The records specialist, assisted by our own filing personnel, reviewed each contract. Tabbed for permanent retention were those covering acquisition, construction, or sales of plant—to be filed with construction records. Those with no historical or plant record value were classified "active", "inactive", or "for destruction", and then subdivided into four major categories:

1. general contracts
2. customer service contracts
3. franchises and tax ordinances
4. land rights contracts

Subject index cards were then prepared and filed alphabetically. Also prepared were termination-of-follow-up cards. These are important because of the nature of our contracts. Some feature open termination, effective on a month-to-month basis after a given period; others are effective only for a firm period. The follow-up cards establish the basis for an annual audit, so that the operating departments can be advised whether given agreements remain in force. These cards are filed alphabetically and are cross-indexed by subject and location.

It was possible upon review to destroy about 60 percent of the documents among the general contracts and the customer service contracts.

The subject files of the accounting department were reorganized on an alphabetical basis. Retention provisions were established to conform with regulatory requirements and company policy. It was found that about 60 percent of this material could be discarded immediately. The remainder was set up for destruction after annual review. New material going into the subject file is analyzed to establish just where it fits into the retention schedule so that it can be properly labelled.

All accounting department files have been brought together in one central location with tight control exercised through a file supervisor. She follows a manual prepared by the Remington Rand specialist to help in day-to-day filing.

Complex and painstaking as this project was, it required no new facilities or office equipment. Only small amounts were spent on repainting steel shelving and file cabinets, buying new file folders, labels, etc.

During the weeding out process, the records were temporarily relocated in the old warehouse and rearranged for better access. Then word came that the old warehouse was to be vacated. The records, by then well organized and reduced to a minimum in bulk, were moved to the basement of our general office building. Here the reduction in space required for files paid off. Space at the old warehouse was charged off at a very moderate rate, but the downtown cost is at least $4 per sq ft. Therefore the reduction in bulk represents a truly important saving.

Not only was the equipment on hand fully adequate to house all remaining documents, but there was plenty to spare for future expansion. The overhaul of our files has reduced space requirements, facilitated filing and finding, and brought a degree of orderliness that has added greatly to efficiency.

KANSAS CITY POWER & LIGHT COMPANY

SCHEDULE OF RETENTION OR
DESTRUCTION OF DISBURSEMENT VOUCHERS

(Pursuant to Federal Power Commission Regulations)

Type of Payment	F.P.C. Item #15a Retention Period	Company Retention Period
Those relating to plant:		
Land	Permanently	Permanently
Production plant, transmission lines and transmission sub-stations:		
Invoices over $5,000	Permanently	Permanently
Invoices $5,000 or less	(2)	20 years
Distribution and general plant other than land	(2)	20 years
Those relating to accounts other than plant:	10 years	See below
Corporate payments such as; registration fees, revenue stamps and similar payments of a significant nature in connection with incorporations, mergers, dissolutions, financing, etc.		Permanently
Deposits with Trustee for interest payments, release of property and purchase fund requirements.		Permanently
Deposits for payrolls, car hire, pensions, etc.:		
With distribution attached		Permanently
Without distribution attached		20 years
Taxes, assessments, etc.		20 years
Donations and contributions (other than petty cash reimbursements)		20 years
Rentals, contractual payments, etc.		20 years
Retainer fees, compensations and payments for special services, i.e., legal, financial, accounting, engineering, etc. (invoices over $5,000 involving plant - see above)		20 years
Deposit for dividend payments		10 years
Payments of dues to trade, social and professional associations		10 years
Coal invoices and freight and express bills		10 years
Petty cash reimbursements		10 years
Advertising		10 years
Purchase of stock items		10 years
Operation and maintenance payments, i.e., laundry, dry cleaning, grocery bills, utility service bills and materials or supplies charged directly to operations, maintenance, clearing accounts, etc.		10 years

[2] 10 years, if (a) accounting adjustments resulting from reclassification and original cost studies have been approved by the regulatory commissions having jurisdiction; and (b) continuing plant inventory records are maintained, or (c) chronological distributions appear in work order records or cost ledger; except that those relating to the construction of licensed projects, or additions or betterment thereto, for which the Commission has not determined the actual legitimate original cost, shall be retained until such cost has been determined.

ENGINEERING/OPERATIONS

Super Weldable Stainless Steel "Blueprint"

Upon basis of test results described before ASTM in Atlantic City this summer, Dr. F. C. Hull, advisory metallurgist at the Westinghouse research laboratories in Pittsburgh, Pa., drew the following "blueprint" for the design of a weldable stainless steel:

"Manganese must be much higher than that normally employed in chromium-nickel steels," he said, "and silicon must be low. Higher strengths should be obtained by adding molybdenum or tungsten. If even higher strength is required, the preferred addition is tantalum not titanium or columbium. The concentration of carbon should be low, although that of nitrogen can be relatively high.

"This basic blueprint has been our guide in developing our new weldable steels," Dr. Hull concluded. "Apparently they are the first to be designed with weldability as the prime objective."

Polyethylene Cable for Puerto Rico

What is said to be the world's first high-voltage, plastic-insulated, electric power transmission cable was recently installed by the Puerto Rico Water Resources Authority, which produces most of the Commonwealth's electric power.

The 6000-ft long 34-kv cable runs from a San Juan substation to a booming suburban area located near the International Airport. The single-conductor 350-mcm cable is made by Simplex Wire and Cable. Its 61 copper coils are insulated with ½-in. thick polyethylene, of a high molecular weight.

Polyethylene is performing well for film packaging of utility equipment, too. A spokesman for Canton Containers, Inc. says, "We recently designed and fabricated a polyethylene cover for a transformer manufacturer, eliminating a shipping and storage problem that was developing into a real profit loser." The transformers, shipped and stored in wooden pallets, are packaged in polyethylene, locking out moisture, dust and dirt, and allowing outside storage.

Spun Secondary Becomes Standard At PS

For the past two years, Public Service Co. of Colorado has been experimenting with "spun secondary." It became a standard operational procedure last month.

Power distribution systems are given a much neater appearance with the new design, says PSCo. Three-phase systems will now have only one crossarm on the pole for the primary lines. Single-phase construction does away with crossarms completely.

In both cases, secondary lines are bound to the neutral or messenger in a single bundle and secured directly to the pole.

During construction, the neutral is secured to the pole with a bracket and the secondary lines are supported by a temporary arm that is removed when construction is completed. The spinner is placed on the neutral and then is pulled along the line, drawing the secondary lines to it and wrapping them all together with two strands of steel wire.

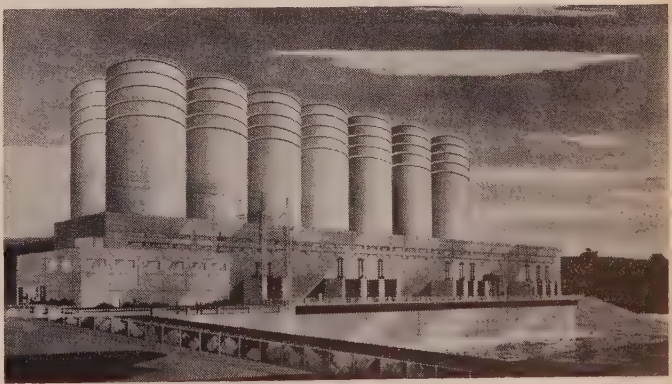
As the spinner approaches the pole bracket, the neutral is removed from the bracket so that the spinner can move past it. The new bundle is then placed in the bracket and the crossarm removed.

In addition to better appearance, the new system offers two other advantages; the stronger secondary is less likely to suffer storm damage, and the placing of transformers at the street instead of in alleys or yards makes the system easier to maintain.

Preview Power Plant Control Advances

Automatic intelligence systems for regulating the overall performance of power plants will be among the outstanding developments exhibited for the first time at the 24th National Exposition of Power and Mechanical Engineering, which is to be held at the New York Coliseum November 28 to December 2.

Giant Surge Tanks for Oahe Dam



Giant surge tanks to be constructed by Graver Tank & Mfg. Co. div. of Union Tank Car Co., in conjunction with Western-Knapp Engineering Co., are shown in this artist's sketch of the hydroelectric power plant for the Oahe Dam, largest rolled earth dam in the world. The tanks, each 70-ft in diameter, will rise 145 ft in the air like giant grain elevators. The surge tanks, risers and penstocks are necessary to control the pressure of water for hydro power ahead of the generating plant. The Oahe Dam and Reservoir on the Missouri River near Pierre, South Dakota, will provide flood protection extending below the dam to the mouth of the Missouri River near St. Louis, Mo.

DIRECTLY-BURIED CABLES COOLED BY WATER . . . CAPACITY UP 50%

Load capability of directly-buried underground cables can be greatly increased by circulating water in adjacent pipes.

By

P. RALSTON and G. H. WEST

The Hydro-Electric Power Commission of Ontario

WHILE STUDYING a thermal problem on a recent installation of 115-kv cables, the Hydro-Electric Power Commission of Ontario investigated the cooling of directly-buried cables, and concluded that it was possible to substantially increase the load capability of this installation by installing cooling pipes adjacent to the cables. The results of these investigations justified further research, and subsequently cooling pipes were incorporated in several directly-buried cable installations.

Although no operating data are available from these trial installations, the theoretical results, which have been confirmed by analogue studies, may form the basis for further development of artificial cable cooling.

Artificial cooling of underground power cables has been studied by many authors who have been concerned principally with the cooling of cables installed in ducts or in tunnels. In the Ontario Hydro transmission system the most common method of cable installation is by direct burial. In duct and tunnel systems the cooling medium is in physical contact with the power cables, whereas in the directly-buried system the cooling medium is contained in pipes buried in close proximity to the power cables. However, these are only differences in detail and do not change the basic heat-transfer problem.

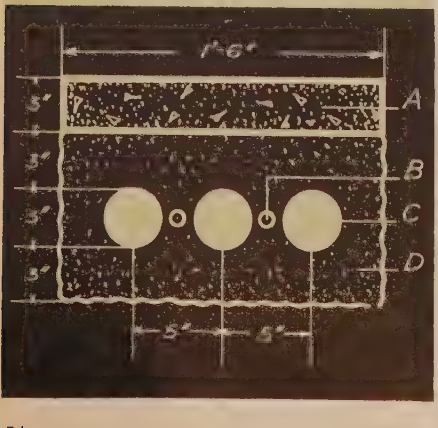


Fig. 1—Cross-section of one directly-buried 115-kv cable circuit with cooling pipes.
A. Concrete cover.
B. 3/4-in. i. d. polyethylene pipes.
C. 115,000-v PILC oil-filled cable.
D. Sand bedding.

Comparative Performance

To illustrate the increase in load capability of directly-buried cables which is possible with water cooling, consider a typical cable circuit consisting of three 115-kv, 1,250,000-cm, PILC cables as shown in Fig. 1.

Calculation of the load capability of the uncooled and cooled circuits is based on a maximum conductor temperature of 85C, an ambient earth temperature and an inlet water temperature of 20C, an earth thermal resistivity of 90C/cm/W, a cooling run of 1000 feet and a water flow rate of 1.46 cubic feet/min/circuit. Using the steady-state cooling equation, the load capability of the uncooled cables is 167 mva and the load capability of the cooled cables is 250 mva. Thus it can be seen that the load capability of this arrangement can be increased by a factor of 1.5 through the use of water cooling employing adjacent water pipes.

Editor's Note—This article is based on a paper prepared by these authors for the 1960 CIGRE meeting in Paris.

Verification of this improvement in load capability awaits completion of the water cooling system, as discussed later. However, partial verification of the cooling equation and the increased load capability has been obtained by means of an analogue field plotter and a thermal model. The analogue field plotter successfully demonstrated the effectiveness of cooling pipes adjacent to the cables. The analogue studies also showed the effective cancellation of mutual heating effects between adjacent circuits when spaced on three-foot centers at normal depths. A thermal model of a typical circuit arrangement was constructed to obtain verification on a dynamic system. The results of the analogue field plotter, the thermal model, and calculations based on the general cooling equation agreed within 10%.

Transient Loading Different

Uncooled underground power cables possess very desirable transient loading characteristics which are often used to advantage in cable systems. Most cable circuits carry power loads which are extremely variable from day to night and it is common practice to design cable circuits so that the daily peak load is considerably above the continuous load rating for several hours at a time. This loading practice is possible because of the large thermal capacity of the earth surrounding the cable. Power cables in air do not have this transient loading characteristic to anything near the same degree.

When artificial cooling is applied to underground power cables and the cables are operated near their cooled rating their transient loading characteristic is very similar to that of power cables in air. The effect of artificial cooling on the thermal circuit in the earth is to reduce the over-all thermal resistance to heat flow from the cable and to reduce the extent of the heat field in the earth. These effects are similar to reducing the volume of earth affected by the cable heat field and hence reduce the over-all thermal capacitance of the thermal capacitance of the thermal circuit. Thus, artificially-cooled power cables do not have the overload capability normally experienced with uncooled cables. This would be a serious drawback if the cooled circuit were operating near capacity at a time a failure in the system made it desirable to place additional load on the cable circuit.

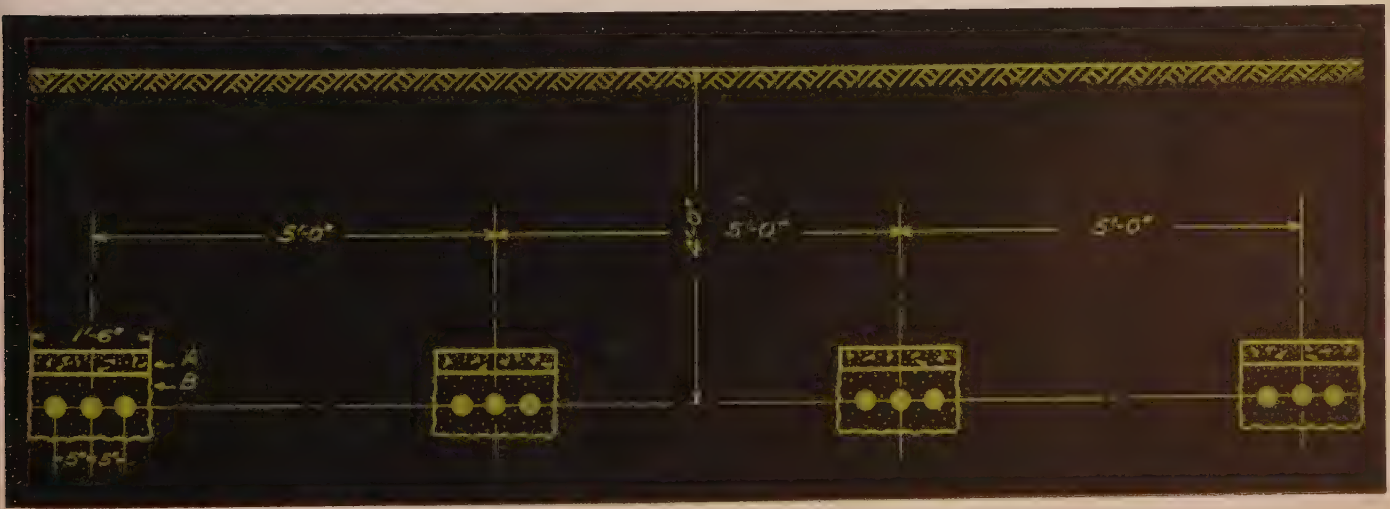
Artificial cooling permits greater copper losses than those for which uncooled cables are normally designed. These additional losses can create higher transient oil pressures in oil-filled cables than normally experienced, unless due allowance is made for this in the cable design. For the same cable design, the number of oil reservoirs required in the cooled system would be greater than that required in the uncooled system by the ratio of the load currents. The greater copper losses also produce a larger temperature drop across the insulation and a larger difference between copper and sheath temperatures. The significance of these latter two factors is not fully known at the present time. A preliminary study has been commenced on the effects of the greater difference between conductor and sheath temperatures to determine if these are detrimental to the lead sheath.

Application By Ontario Hydro

Water cooling for underground cables was first studied by Ontario Hydro during the installation in 1957 of four 115-kv underground cable circuits along the Toronto waterfront. The cables specified were 1,250,000-cm copper, single-conductor, low-pressure, oil-filled, lead-sheathed directly-buried cables, each circuit being designed to carry 140 mva continuously with a maximum conductor temperature of 85C. The three cables of each circuit were to be spaced on 5-inch centers, with the four circuits parallel on 5-foot centers (see Fig. 2). The nominal depth of burial was four feet, the thermal resistivity of the soil was 100C/cm/W, and the design ground ambient temperature was 20C.

A late change in route made it necessary to cross adjoining railway and expressway embankments, where the contour of the ground was such that the cables had to be installed at an average depth of about 20 feet for a distance of about 350 feet. For other reasons it was also necessary to install the cables in ducts at this location. The added thermal resistance, due to the combination of greater depth and installation in ducts, would have resulted in this section having a rating of

Fig. 2—Cross-section of four-circuit, 115-kv underground cables installed along Toronto waterfront.
A. Concrete cover. B. Sand bedding.



only 80% of the design value. Various alternative methods of overcoming this problem were studied but were rejected because of time limitations, so three spare ducts per circuit were installed to carry cooling water (see Fig. 3). Studies made on the analogue field plotter showed that this method would easily raise the load capability of the cables at this location to the design value.

It was then realized that if the entire cable installation could be cooled, the future need for two similar circuits might be eliminated. The added cost for installing the pipes was so small (about 1% of the total cost), and the potential future savings so great, that it was decided to proceed with the installation of ¾-in. polyethylene cooling pipes as shown in Fig. 1.

At main road crossings, local regulations required that the cables be installed in ducts, and as the duct banks had been constructed before water cooling was considered, only three 4-in.-diameter ducts had been installed for each circuit. These ducts would not accommodate both cable and ¾-in. plastic pipe, but in some cases it was possible to pull two ½-in. pipes into each duct (see Fig. 4). At three locations this method had to be abandoned because of difficulties encountered in pulling in the pipes, and an alternative method of cooling these duct banks must be devised.

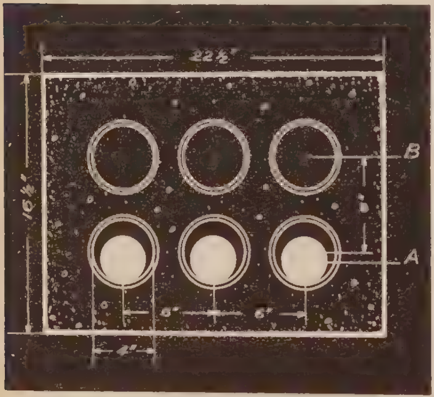
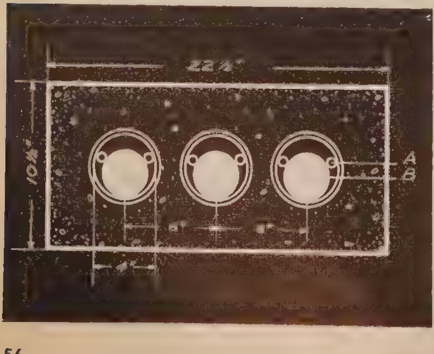


Fig. 3—Cross-section of installation in ducts through embankments (one cct. shown).
A. 115,000-v PILC oil-filled cable.
B. Spare ducts for water cooling.

Fig. 4—Cross-section of duct at road crossings (one cct. shown).
A. 1/2-in. i. d. polyethylene pipes.
B. 115,000-v PILC oil-filled cable.



Provision for future water cooling by means of two ¾-in. polyethylene pipes per circuit was subsequently made on two double-circuit installations of similar cable in 1958 and 1959. In these installations, 5-in.-diameter ducts were installed where necessary, so that the ¾-in. pipes could be pulled through the same ducts as the cables without difficulty.

It had been intended that the cooling system through the embankment of the Toronto waterfront cables would be in operation by midsummer of 1958. However, completion of this cooling system was deferred because of more pressing work, and it is now expected that it will not be in operation until late in 1960. As the loads carried by these cables are not yet large enough to exceed the uncooled ratings, there is ample time to carry out extensive field tests before the forced cooling is a necessity.

Must Look To Future Needs

It is conceivable that in the future Ontario Hydro will require cables to carry loads far in excess of the capacity of any known cables of a practical size, in which case it would be necessary either to install two cables per phase or to resort to artificial cooling.

For example, in 1961, Ontario Hydro will install two circuits of 230-kv cable which will be part of an installation which will ultimately comprise at least six, and possibly eight, similar circuits. The circuits will be installed in pairs and must each be capable of carrying 340 mva at 100% load factor. With one circuit of a given pair out of service, the other circuit must be capable of carrying the full load of 680 mva for that pair at 75% load factor.

With soil thermal resistivity of 80C/cm/W the conductor size required is at least 2,500,000 cm, providing that the circuits are thermally independent and that the phases of each circuit can be spaced at least 15 inches apart. As it is Ontario Hydro practice to insulate cable sheaths and use some form of cross-bounding to reduce sheath losses, at this phase spacing either the induced sheath voltages will be excessive or an inordinate number of joints will be required. This problem could be largely overcome by closing up the phase spacing and installing forced cooling to eliminate the mutual heating between phases.

To add to the difficulties of this installation, there are only two narrow roadways available in which to install these circuits, and the road authorities are reluctant to grant permission to install the circuits far enough apart to make them thermally independent of one another. It might, therefore, be necessary to purchase right-of-way on private property. Artificial cooling would greatly reduce the space required between circuits, and thus reduce the cost of right-of-way.

It appears that this is the type of installation in which artificial cooling can be used to best advantage. Although the technical problems of cooling can be solved, there arises the question of service security. When cables of relatively high importance are involved, extreme caution must be exercised when considering a system which is still in the development stage. It is hoped that by the time the next two circuits are required (in 1963), enough data will have been accumulated to provide a firm foundation on which a thoroughly reliable design can be based.

Control-System Considerations

The flow of cooling water can be controlled either manually or automatically. If automatic control is not desired, it is only necessary to have the water turned on when the load reaches a predetermined value, and turned off when the load drops below that value. In this case, it might be economical to operate with water cooling continuously for several hours during the peak period of each load cycle. This is a matter of preference for the individual electric utility and would depend largely on the shape of the load curve. The main drawbacks of manual control are first, severe leaks in the cooling system might be unnoticed for a prolonged period, thus depriving a portion of the cable of the required cooling; and second, manual control would undoubtedly be wasteful of water.

Ontario Hydro are presently designing a method of control which will automatically regulate the water flow in the Toronto waterfront cable cooling system. The following outlines the basic principles:

1. **Leak detection**—Leak detection will be performed when the cooling system is standing-by but not operating. Under this condition, the system will be closed and under pressure. The system will differentiate between minor and severe leaks, and the severe leaks will actuate an alarm which will be annunciated at the controlling station. The location of leaks must be determined in the field by isolating each section of pipe individually.

2. **Water flow control**—The control system should turn the cooling water on or off automatically, depending on the requirements of the cables. This can be done by solenoid valves actuated either by temperature-sensing devices on the cable sheath, or by current-sensitive relays with the current supplied by current transformers around one of the cables. The control system should be designed to give an alarm if any part of the cooling system or control system fails to operate.

Final design of the control system for the Toronto waterfront cable cooling system might prove to be too costly to incorporate all these features. In this event, a compromise will have to be made between cost and security. However, the authors believe that if, in the future, the proper facilities are installed at the time of the cable installation, the cost and complexity of a complete control system can be kept within reasonable bounds.

Economic Considerations

The authors have not yet done a complete analysis of the economics of water cooling, because they have not accumulated data on either installation costs or operating costs. In the absence of these data, it is difficult to state any definite rules as to when forced cooling is economical, so that this discussion will be limited to a brief presentation of the factors which must be considered. It will be obvious that the discussion of these factors is largely speculative, but serves to indicate the direction which further studies should take.

1. **Availability of water**—The first requirement is that there be an ample supply of water at a reasonable cost. At some localities there might be restrictions which preclude the use of the municipal water supply for cooling purposes.

2. **Conductor size**—Cooled cables require a smaller conductor than uncooled cables to carry a given load, and the resultant savings in cable costs should be weighed against the cost of the cooling system. As in the case of transformers or generators, it is expected that forced cooling will be most beneficial when the quantity of heat to be removed is large; that is, when large blocks of power are involved.

As the mutual-heating effect between circuits can be reduced to almost negligible proportions, it is reasonable to expect the efficiency of the cooling system to increase as the circuit spacing decreases. Therefore, with multiple circuits of a given conductor size, the costs for installing and operating the cooling system must be weighed against the extra installation costs for wider circuit and phase separation, and the additional cost of right-of-way for uncooled circuits.

3. **Cost of cooling system**—With a specific cable system, and assuming a constant water-inlet temperature, the degree of cooling to be obtained varies with the pipe diameter, the number of pipes, the water velocity, and the length of the cooling run (i.e., number of supply and drain points). The selection of the most economic system requires a careful evaluation of all these factors. It should be observed that increasing the number of supply and drain points not only increases the cost of the cooling system itself, but also the cost of the control system.

4. **Induced sheath voltage and number of joints**—Where directly-buried cables are operated with isolated sheaths, and where the individual phases are widely separated to improve the thermal characteristics, the induced sheath voltages are considerably increased. Because of the possibility of alternating-current corrosion, some electric utilities place an upper limit on these induced voltages, which increases the number of joints required. The use of forced cooling permits reducing the phase spacings, thus reducing the number of joints, while at the time maintaining or even improving the load capability of the circuits. Each case should be studied individually, however, as the higher transient oil pressures of cooled cables might require additional reservoirs and stop joints.

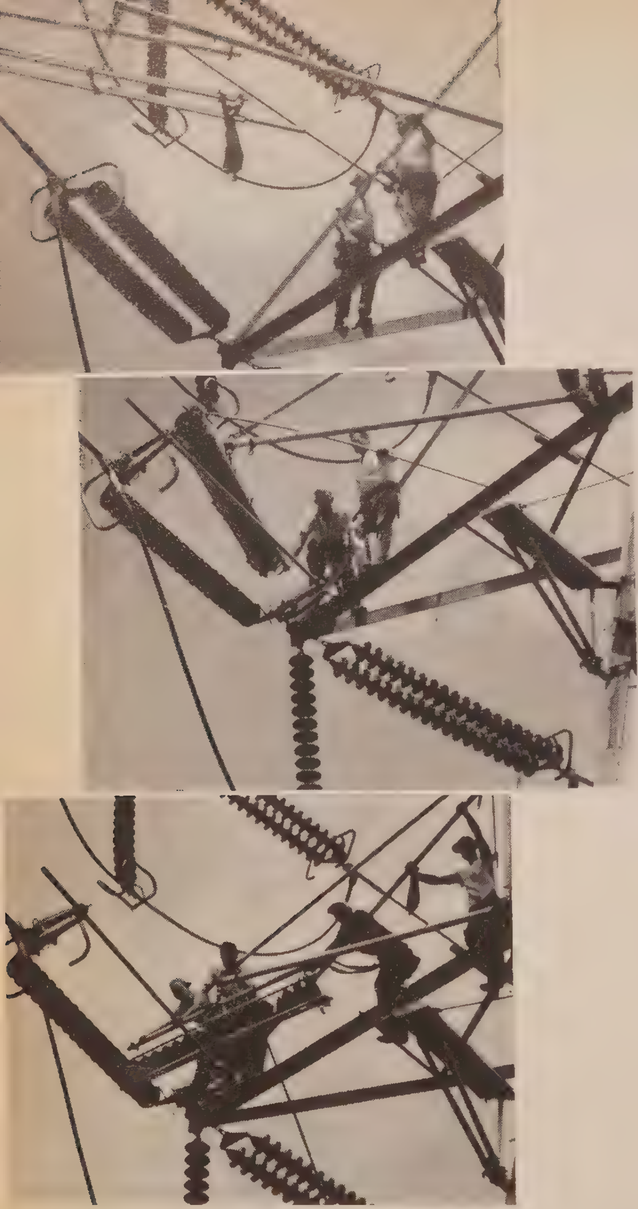
5. **Emergency ratings**—It has been demonstrated that normally force-cooled cables do not have the same capability to carry short-time overloads as uncooled cables. On the other hand, the emergency-loading condition is the governing criterion for many cable installations, so that forced cooling might prove to be justified if used only to increase the emergency ratings of normally uncooled cables.

6. **Cost of operation**—The use of water cooling implies the use of a smaller conductor with consequent higher losses. The cost of these losses must be added to the cost of water, in order to obtain a true evaluation of the operating costs. The extra costs incurred by maintenance of the water and control systems must also be added.

No general conclusion can be drawn, as each installation must be studied on its own merits. Except that there are more variables involved, the evaluation of the comparative economy of cooled and uncooled cables can be established in the same manner as for two different conventional systems.

Ontario Hydro will pursue their investigations in this field, since the results so far obtained are sufficiently encouraging to warrant the accumulation of more data from full-scale installations.

HOW AEP MAINTAINS 345-kv LIVE LINES



Tension Assembly—Step 1. (Top) Combination cradle and tension jack being adjusted and put in place, in preparation to replacing broken insulator. Step 2. (Center) Insulator string disconnected at both ends. Weight of string and cradle are lifted by boom attached to tower, raised and lowered by ratchet hoist at top. Step 3. (Bottom) Removing and replacing broken insulator. Note broken insulator from right to left.

Live-line maintenance work at 345-kv is as commonplace with American Electric Power System companies as is the use of rubber protective equipment for distribution voltages. But extreme care and adequate equipment is mandatory and the hazards involved must be recognized.

By
W. PRICE CARTER
System Transmission Line Superintendent
Appalachian Power Company

The American Electric Power System operating companies have developed methods for 345-kv live line maintenance that are believed to be feasible, not only for routine work but that are probably less hazardous than those sometimes practiced at considerably lower voltages.

We have had to meet the obligation of ever increasing power demands by resorting to higher transmission voltages. Associated with the higher voltages is a greater demand to keep the transmission lines continuously energized if we hope to maintain a high standard of service. Since it is obviously necessary to perform work on these high-voltage lines from time to time because of damage that may be incurred by windstorm, lightning and other hazards, it is necessary as a part of maintenance work that these lines should not be de-energized to perform such maintenance work.

Problems Not Standardized

While live-line maintenance is not new, the problems associated with it are not so well standardized that we can apply the practices that are common at lower voltages to the higher transmission voltages. This involves not only electrical hazards but mechanical hazards as well. Each time we adopt a voltage higher than that which has previously been maintained by live-line practices, we must proceed with caution, since mistakes or lack of recognition of the hazards may have fatal consequences.

In 1947, during construction and field testing of experimental lines and voltages, we together with other operating companies of the American Electric Power System, began considering the limitations of working the contemplated 345,000-v ilnes and stations with wood-stick insulated tools.

Tools and equipment used for somewhat lower transmission voltages were not adaptable for working transmission line conductors of 1.75-in. diameter, weighing approximately 2.1 lb per ft and requiring the added lengths to provide enough insulation to assure absolute safety to workmen when working on 345,000-v lines. Longer and stronger sticks were necessary. Twelve feet is now the minimum length for these tool sticks and workmen keep their hands within 4 ft from the end, allowing 8 ft of stick between themselves and the metal toolhead. Sticks of this length become unwieldy and require skill to manipulate them; all the while the workmen must remain at a safe distance from the conductors while standing on steel frame structures 100 ft or more above the ground.

Replacing Insulators

When replacing insulators, sticks are used both to provide insulation and to carry the load of whatever they are applied to. For this purpose lift and jack sticks have to be longer and of greater mechanical strength. Two lift sticks are used for lifting the conductors on tangent towers an done jack stick on dead-ends to take the line tension. Lift sticks are designed for a breaking load of 6,500 lb each and the jack sticks for 16,500 lb each.

The electrical hazards are not difficult to surmount as long as these hazards are recognized. Obviously it is necessary for workmen to remain a safe distance away from the energized lines. We know that these voltages will flash over distances in air equivalent to about 1 in. for each 10,000 v; thus the voltage will flash over a distance of nearly 3 ft between conductors; and since the nominal voltage to ground is about 200 kv, it will flash over about 20 in. to ground. To these distances must be added a safety factor because of switching surges and lightning which are much higher than the normal operating voltage.

Inclement Weather

We do not attempt live-line maintenance work in inclement weather; but if a sudden electrical storm catches you on the job, it may require protection from fairly high voltages. If lightning strikes a line even though it may be some distance away from the work area, and causes a circuit breaker to operate, it is possible to get two to three times the normal line voltage, which could be a million volts phase to phase or about 600,000 v to ground. Hot sticks are normally rated 75,000 v per ft as a top safe limit so that if a switching surge should occur having a voltage of more than 2½ times normal, the hot sticks would be stressed to the maximum of their rating. Switching surges rarely reach this magnitude; however, we must be prepared for the worst.

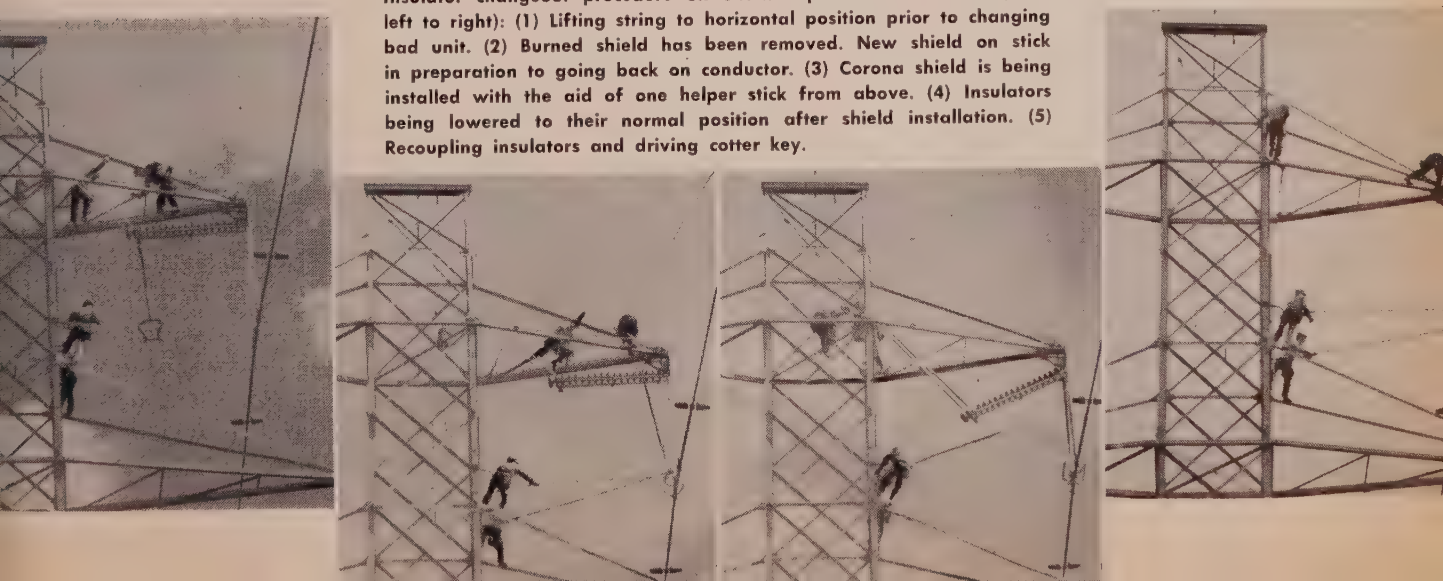
Manual Control

An added precaution against the possibility of overvoltages occurring due to breaker operation while work is in progress consists of having these circuit breakers changed to manual control for reclosing. If a line should drop out while work is in progress, there would be a 5-min delay for which a hold card is placed on the contro lswitch before the line is re-energized. This provides enough time so that workmen can get themselves in the clear before the line is re-energized.

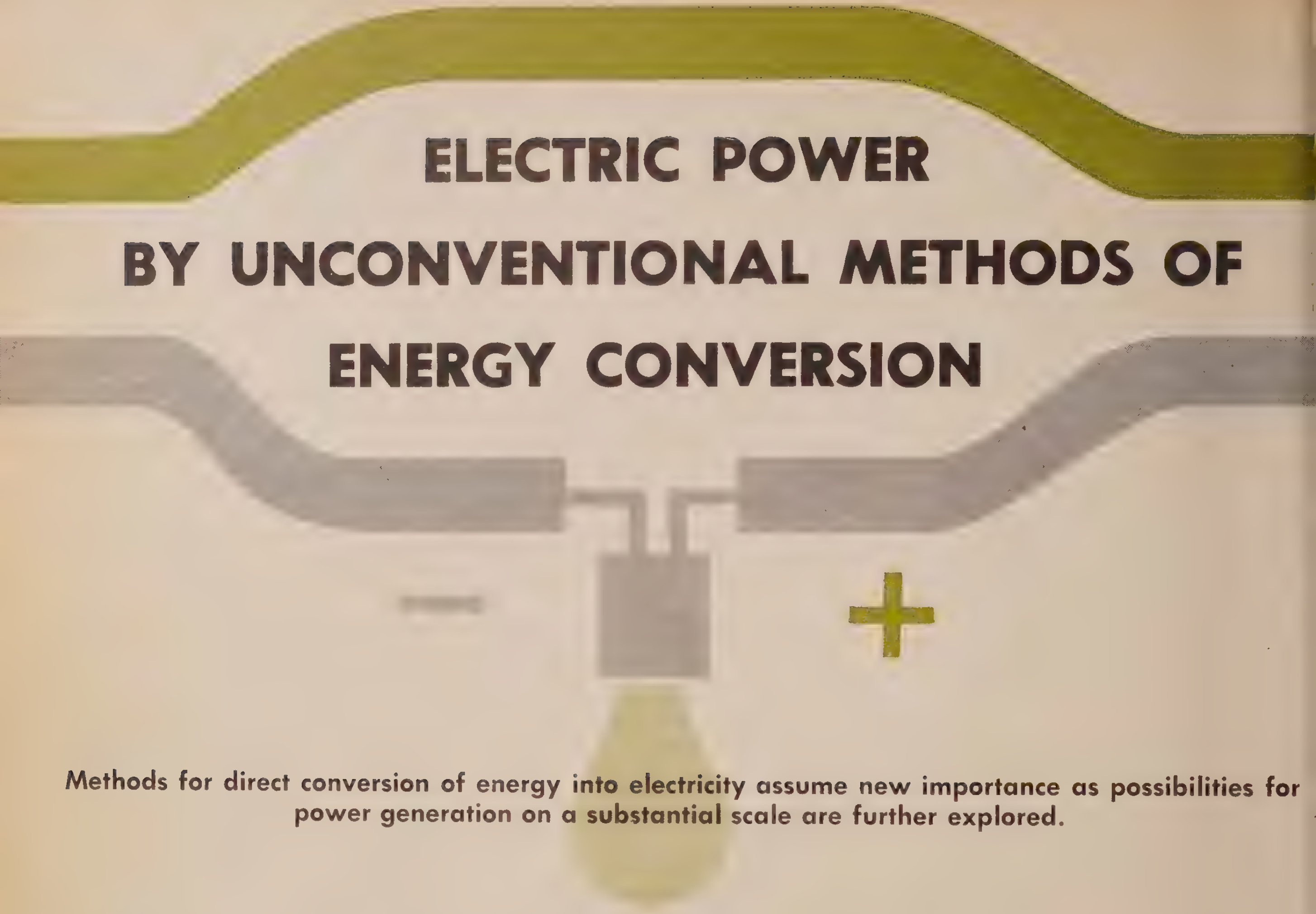
Space Becomes Charged

Another hazard, which is not so commonly recognized but which is of equal importance, is due to the fact that at the higher voltages the space between conductors and tow-

(Continued on page 113)



Insulator changeout procedure on 345-kv Sporn-Kanawha line (from left to right): (1) Lifting string to horizontal position prior to changing bad unit. (2) Burned shield has been removed. New shield on stick in preparation to going back on conductor. (3) Corona shield is being installed with the aid of one helper stick from above. (4) Insulators being lowered to their normal position after shield installation. (5) Recoupling insulators and driving cotter key.



ELECTRIC POWER BY UNCONVENTIONAL METHODS OF ENERGY CONVERSION

Methods for direct conversion of energy into electricity assume new importance as possibilities for power generation on a substantial scale are further explored.

By

P. E. Benner, A. G. Mellor, and J. B. McClure, Power Generation Engineering, Electric Utility Engineering, General Electric Company

DEVELOPMENT EFFORTS on direct conversion of energy into electricity have been greatly stimulated by the power-supply requirements of missiles and space vehicles. Progress in this special field has naturally resulted in increased interest in the possibility of applying these same concepts to land-based power generation on a substantial scale.

Specifically, there are four methods of conversion which are being given increased attention—thermoelectric, thermionic, magnetohydrodynamic and fuel cells. All of these are being seriously considered either as power sources for special purposes or as improved means of bulk electric-power generation.

Before discussing some of the details of these methods of power generation, it may be well to consider briefly some of the economic factors associated with commonly-accepted power generation systems today. This will provide a common basis for considering what the target is, in an economic sense, that these new methods will have to meet or better.

Table I shows the approximate dollars per kilowatt and thermal efficiency for several different types of conventional power generation. For all the thermal types of generation, power costs will vary widely depending on the cost of fuel in various parts of the country.

Including nuclear power as a conventional method of power generation may be somewhat optimistic, but sufficient work has now been done in this area that a realistic approximation can be made of power costs from this source.

Over a period of many years, other sources of power have either been extensively studied or, in some cases, tried out on a small scale. Many of these, such as tidal power, from the wind and solar power, have not, to date, proved economic and at best will only be intermittent sources of power. If used on any other than a "when available" basis, they involve storage systems of some type.

More recently, the development of geothermal power has been undertaken on a small scale. It appears that this will have very limited application as suitable steam-supply sources occur in only a few locations in the world.

Mention should also be made of power from nuclear fusion or the so-called controlled hydrogen-bomb reaction. Theoretically, the development of this process would provide ie world with an almost unlimited ipply of power, thus removing iost of the concern about future iel supplies. However, it has not et been definitely demonstrated iat a fusion reaction can be initited and carried on in a controlled ianner. Much research and deelopment work remains to be done nd, at present, it seems that fusion ower must be looked upon as an ttractive, longer-range power ource but cannot be counted upon or the near future.

With this background, the four nconventional power conversion nethods mentioned earlier will be liscussed in more specific terms.

Thermoelectric Generation

Thermoelectric generation is the lirect conversion of heat into elecricity based on a phenomenon nown as the Seebeck effect by vhich current is produced in a losed circuit of two different metals if the two junctions are maintained at different temperatures. (Fig. 1) For many years the only practical application of this phenomenon was for thermocouples for measuring temperatures. This was probably due to the fact that when metals are used, the conversion efficiency comes out to be less than 1%.

The characteristics of a material on which are based its thermoelectric evaluation include in addition to its Seebeck coefficient, S, its electrical resistivity, p, and its thermal conductivity, k. These are combined to give its figure of merit, Z, as follows:

$$Z = \frac{S^2}{pk}$$

An ideal thermoelectric material would have a high Seebeck coefficient, a low electrical resistivity and a low thermal conductivity. The conversion efficiency of a thermal pile is a function of the figure of merit, the hot junction temperature, and the temperature difference between the hot and cold junctions, and is therefore Carnot-cycle limited.

Recent interest in thermoelectric generation dates from the discovery that certain semiconductors have thermoelectric properties greatly superior to conductor materials. Also, in some types of semiconductors, the voltage difference between the hot and cold junctions is not set up by the flow of negatively-charged electrons but by the flow of positively-charged voids vacated by the electrons. As a result, the cold junction of such a semiconductor becomes positively charged in contrast to the hot junction of the semiconductor becoming positively charged where the voltage is generated by the flow of electrons. The two types of semiconductors are designated "n type" (hot junction positive), and "p type" (cold junction positive). The direction of current (electron) flow is assumed positive to negative in the semiconductor material or negative to positive in the external circuit. (Fig. 2)

The application of semiconductor materials to thermoelectric generators has increased the efficiency of conversion more than tenfold and has now made this source of power attractive for some applications not dominated by efficiency or cost limitations.

A large number of the major research facilities in this country and abroad are actively engaged in this field, some in materials research and others in the applications of materials into thermoelectric generators. The number of materials being examined is large, and the number in which suitable properties might conceivably be found is very much larger.

High-temperature thermoelectric materials are required to achieve higher over-all efficiency. High temperature operation increases the tendency of materials to sublimate, oxidize, or become poisoned. In some cases, encapsulation is the solution for this type of problem and makes it possible to extend the useful temperature range of material application.

Present technology has produced thermoelectric generators with efficiencies as high as 10%. In evaluating the future possibilities, the optimist points to the tenfold to twentyfold improvement achieved in the recent past, and figures that a further break-through of much smaller magnitude than that brought about by semiconductors might make thermoelectric generation economically competitive.

As mentioned previously, present

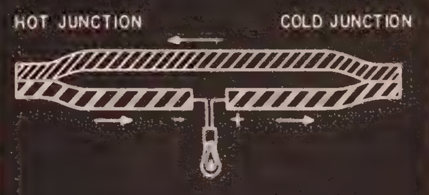


Fig. 1—Diagrammatic representation of thermoelectric generation.

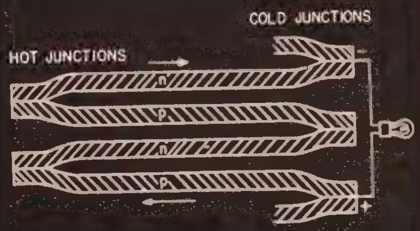


Fig. 2—Thermoelectric generation utilizing semiconductors.

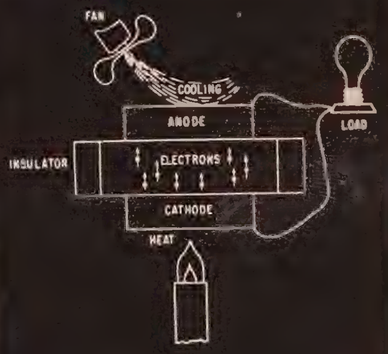


Fig. 3—Simplest form of thermionic converter.

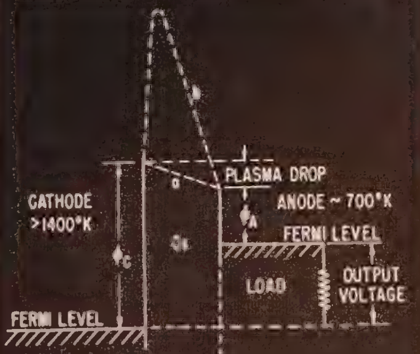


Fig. 4—Chart of action which takes place in a thermionic converter.

TABLE I

CONVENTIONAL ELECTRIC POWER GENERATION

Method	Approximate $/kw	% Thermal Efficiency
Steam-Electric	150	38
Hydro	150-350	—
Gas Turbine	115-180	21-26
Diesel	115-220	33
Nuclear	250-400	28

TABLE II

TYPICAL MHD GENERATOR DESIGN

(543,000 kw Total Output; 300,000 kw MHD Output)

Inlet total pressure	5.5 atm
Inlet total temperature	4730F
Magnetic field strength	20,000 gauss
Gas flow	3,010,000 lb/hr
Gas velocity	2400 ft/sec
Length	85 ft
Terminal voltage	4000 volts
Width between electrodes	11.2 ft
Height at entrance	1.0 ft
Height at exit	3.3 ft
Exhaust total temperature	4120F
Preheat air temperature	2311F
Power for exciting magnet	6200 kw
Weight of steel in magnet	12,000 tons
Weight of copper in magnet	600 tons
Seeding material injection and recovery	30,000 lb/hr

applications are limited to fields where efficiency is not important. For instance, the Russians are producing a kerosene-lamp-heated thermoelectric generator for poweringing small radio receivers in remote locations and are considering a larger wood-stove-heated generator for powering two-way communication sets in locations where electric power is not available. In this country, the AEC has sponsored the development of the SNAP III in its nuclear auxiliary power program. This device was built by the Martin Company using thermoelectric material from Minnesota Mining and Manufacturing Company. It uses polonium 210 as a heat source and produces 5.3 to 2.4 watts (half-life) with an efficiency of approximately 5%. This device has a diameter of 4.75 inches, a height of 5.5 inches and weighs 5 pounds. The polonium has a half-life of 138 days and the device itself will produce more power in its useful life than several hundred times its weight of conventional batteries.

Before widespread application of thermoelectric devices can be established there are several problems that must be solved:

1. Materials. New materials must be discovered or developed having a higher figure of merit. To properly channel the search for these new materials, a better understanding of the basic phenomenon involved is required. For higher efficiency, materials must also be stable at high temperatures.
2. Hot-junction fabrication and materials to provide good thermal conductivity and electrical insulation.
3. Methods of control of thermoelectric generators must be developed. Present concepts of control of the output require control of the thermal input to the device. This is not a very satisfactory type of control due to the inertia or thermal time lag involved.

Thermionic Conversion

In its simplest form, a thermionic converter is a vacuum—or gas-filled device with a cathode, maintained at a high temperature, emitting electrons, and a cold anode to collect the electrons as shown in Fig. 3. As shown, means must be provided to heat the cathode and to cool the anode and suitable electrical connections to the cathode and anode provided. The thermionic converter is a special form of vacuum-tube diode.

Figure 4 will help to explain what takes place in a thermionic converter. It is a plot of the energy of an electron at various locations in the diode. The abscissa is cathode-anode spacing and the ordinate is electron energy. If the base is the energy of the electrons in the cathode, then heating of the cathode lifts some of these electrons over the work-function barrier at the surface of the cathode into the inter-electrode space. This work-function barrier is analogous to the escape velocity of a rocket from the earth. The lower the work function the easier it is for an electron to escape from the surface of the cathode. An escaped electron has potential energy relative to the electrons in the metal and also has kinetic energy directed toward the anode.

If it is assumed that the electrons can follow path *a* to the anode with only a small loss of energy, they will fall down the work-function barrier as they join the electrons in the anode. If the electrons in the anode are at higher potential than the electrons in the cathode, there is a potential difference available as output voltage capable of doing work in an external circuit.

It can be seen that it is important to have the work function of the anode as small as possible and since this work function is small, the anode must be kept cool to prevent anode emission or back current.

It was assumed above that the electrodes could follow path *a* from the cathode to the anode with little loss of energy. However, since elecons are charged particles, the lectrons in the space between the athode and anode form a space-harge barrier between the elecrodes as shown by line *b*. This pace-charge barrier can seriously mit the number of electrons that an flow to the anode by turning ack many of the electrons emitted rom the cathode. Space-charge ormation can be reduced by bringng the cathode and anode surfaces ery close together or by introducng a suitable gas atmosphere that an be readily ionized and used to eutralize the space charge.

It is of interest to see what effiiency we can get out of such deices. To date, on laboratory models hermal efficiencies approaching 17% have been achieved; however, we could not expect today to achieve efficiencies this high in production units designed for long ife. Looking ahead to possible future ultimate efficiencies, it appears that a figure of 30% or a little more may be possible by achieving very much higher electrode current densities. These may seen like rather low efficiencies compared with the thermal efficiencies obtainable today from more conventional power sources but in this connection we must consider where these devices might be applied.

At present there seem to be two major areas of application for thermionic converters:

1. As special power sources for military applications, particularly as solar or nuclear power sources for space vehicles. (Fig. 5). In these applications the relatively light weight of the thermionic converter is of major importance, and efficiency level is not a vital factor since competing sources of power may be of even lower efficiency and be very much heavier.
2. As topping units for more conventional thermal cycles. Thermionic converters operating at high input temperatures can reject heat at quite high temperature which is suitable for use in a conventional thermal cycle. However, thermionic converters for use at the high temperatures will require future development. In a topping cycle, the efficiency of the thermionic converter is not of major importance as all the heat rejected by the thermionic converter is available to the conventional thermal cycle.

The output voltage of a single thermionic converter is quite low—between one and two volts but, by arranging many of them in series, voltages of a reasonable level could be achieved.

There are obviously many problems that must be solved before thermionic converters with long life will find wide economic application, among which are the following:

1. A far better understanding is required of the phenomena of electron emission, space-charge effects and the behavior of cesium plasma.
2. Develop better cathode materials that can withstand high temperatures.
3. Develop stable anode materials which have a low work function.
4. Develop fabrication techniques for these unusual materials.

Magnetohydrodynamic Power

The principle involved in magnetohydrodynamic power generation has been known for many years. It involves the interaction of electromagnetic fields with electrically-conducting fluids.

In a conventional electric generator, mechanical energy is converted into electric energy by the motion of a metallic conductor through a magnetic field. In a magnetohydrodynamic generator, the conductor is a partially ionized gas which is forced through a magnetic field by a pressure difference.

Figure 6 is a schematic representation of a simple MHD generator. It consists of a duct through which the hot ionized gases flow, a magnet to produce a magnetic field across the duct, and electrodes which form the sides of the duct. Due to the motion of the ionized gas through the magnetic field, a potential difference is generated in the gas which causes a current to flow through the gas, the electrodes and the external load.

For such a device to be practical, it appears necessary to operate at very high gas temperatures where some degree of ionization occurs. This ionization can be enhanced by the addition of seeding materials having a lower ionization potential than the main gas. However, even with seeding it appears that it will

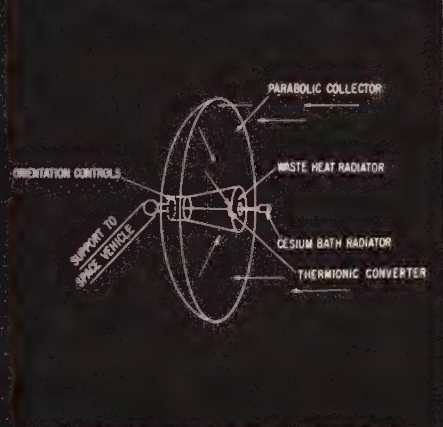


Fig. 5—Sketch showing use of thermionic converter in power source for space vehicles.

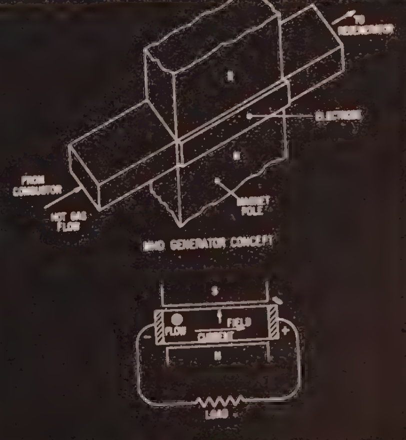


Fig. 6—Schematic representation of a simple magnetohydrodynamic generator.

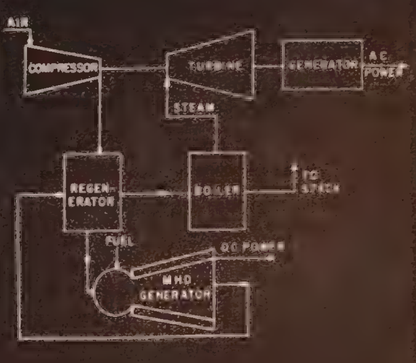


Fig. 7—Schematic arrangement of a possible combined MHD-boiler, turbine-generator station.

TABLE III

Comparative Efficiencies Of Unconventional Methods Of Energy Conversion To Electric Power

	Device Thermal Efficiency		*Thermal Efficiency in a Combined Cycle*	
Method	*Present*	*Possible Future*	*Present*	*Possible Future*
Thermo-electric	10	30	—	—
Thermionic	17	30	48	56
MHD	12	26	45	54
Fuel Cell	40-75	50-80	—	60-70*

**Includes gasification*

be necessary for the gas temperature entering the MHD generator to be of the order of 5000F with an exhaust gas temperature from the MHD generator of the order of 4000F.

The high exhaust-gas temperature from the MHD generator suggests that this device, if it can be developed, would be most applicable as a topping unit over a more conventional thermal cycle. For example, the exhaust gas could be used in a more or less conventional boiler to produce steam for a conventional turbine-generator plant.

Figure 7 shows a schematic arrangement of a possible combined MHD-boiler, turbine-generator station.

Air is first compressed to provide pressure to force the ionized gases through the MHD generator. To obtain the required high MHD gas-inlet temperature, the air must then be highly preheated before passing to the combustor. This is accomplished in a heat exchanger or regenerator using exhaust gas from the MHD generator to provide the heat. Fuel, in this case coal, is burned in the combustor using the air which was sufficiently preheated to result in a final combustion-gas temperature of the order of 5000F. Seed material is introduced to enhance the ionization, and the hot, partially-ionized gases then pass at high velocity through the MHD generator where the temperature is dropped to about 4000F at the exhaust of the MHD generator. The exhaust gas then passes through the heat exchanger and is discharged into a boiler where steam is produced in the conventional manner. The boiler-steam turbine-generator portion of the combined plant is the same as a conventional generating plant.

The use of MHD in such a combined plant could result in an improvement in net station-heat-rate of approximately 15 to 30% or, in other words, could raise the thermal efficiency of the generating station from today's 38% for a conventional steam-electric station to about 45-54%. This potential gain in efficiency of power generation is the incentive for trying to develop a MHD generator for large central-station power generation.

Table II shows some theoretical calculated figures for a large-sized MHD generating plant. These are only intended to be indicative of possible parameters for such a plant and have not been optimized in any way. Based on different assumptions, very much different figures would be obtained.

It is apparent that before any plant of this type could be considered, many major problems must be solved and much research and development work carried out, such as the following:

1. A far better understanding must be obtained of the electrical conductivity of gases at high temperatures and the effectiveness of seeding materials. This information is basic to the design of an MHD generator and at present data in these areas is extremely meager.
2. The problems of material requirements for use at temperatures of 5000F are extremely severe. Very few materials are even solids at this temperature and those that are have very little structural strength.
3. Electrodes have not yet been built that are capable of operating for any length of time at these high temperatures. I does not appear that it will be possible to cool the electrodes much below the gas temperature; otherwise a layer of coo un-ionized gas adjacent to the electrode would seriously affect the gas conductivity. In an open-cycle MHD generator using coal as a fuel, the electrode problem is further complicated by the fact that the electrodes are exposed to a dirty and erosive atmosphere
4. A combustor must be developed that is capable of operating on highly-preheated air at high pressure and capable of withstanding the extremely high temperature o the products of combustion.
5. Similar materials problem will be encountered in the regenerator. While temperatures here are not as high a in other parts of the cycle they are considerably highe than temperatures normally used in heat exchangers.
6. For reasons of economy, it wil be necessary to recover th seed material from the combustion gases after they hav passed through the MHD generator. This will require th development of suitable separating equipment.

The Fuel Cell

A fuel cell is an electrochemica device in which the chemical energ of a conventional fuel is converte directly and usefully into electrica energy. It may be regarded as battery in which fuel is oxidize at the anode, and oxygen (preferably from air) is reduced at th cathode. An electrolyte carries th current internally, and electron flow from anode to cathode in a external circuit.

The inherent simplicity of th fuel cell as a source of electrica energy is obvious from Fig.

ut an even more attractive feature this device is that it converts ergy free of the Carnot-cycle mitation. It can do this because it onverts chemical energy directly ito electrical energy and by-passes ie intermediate conversion to heat iat occurs during combustion.

The fuel cell produces low-voltge direct current and its output oltage is a function of current rain. A typical voltage-current rain plot, commonly called a olarization curve, shows a derease in voltage with increasing urrent, as in Fig. 9. As a result f these characteristics, provision or conversion must be made if -c power is desired. Likewise, if onstant voltage under varying load s required, voltage regulation and ontrol equipments must be added.

With one exception (the Redox ell), all fuel cells under development today require for the generaion of electricity the reaction of uel and oxidant in gaseous form lirectly at their respective electrode surfaces.

In the simplest type of cell, the chemical or catalytic action takes place at the line where the electrolyte, gas and electrode meet. Obviously, in such a cell the reaction is very limited. One of the major problems in designing a practical fuel cell has been and still is obtaining greater reaction area. Research has explored many avenues to overcome this limitation and a number of ingenious schemes have been devised. A brief description of some of the more important of these schemes will provide an indication of the present status of fuel cells and the magnitude of the efforts in this field of development.

One of the simplest of all hydrogen-oxygen (Hydrix) fuel cells is the ion-exchange membrane cell. A schematic section of this cell is shown in Fig. 10. The membrane is contained on either side by wire screen electrodes, each coated with a catalyst to facilitate chemical reaction. Hydrogen is oxidized at the anode, forming hydrogen ions which enter the membrane electrolyte and electrons which flow through the external circuit. The hydrogen ions pass through the ion-exchange membrane to the oxygen electrode (cathode). At the cathode, oxygen is reduced by the electrons from the external circuit and combines with the hydrogen ions from the membrane electrolyte to form water which is drawn off or evaporated. The over-all result is the controlled combination of hydrogen and oxygen to form water with the release of useful electrical energy.

Basic problems with this type of fuel cell are the high cost of the catalyst and the need to use pure hydrogen which is relatively expensive.

Another interesting design is the "Redox cell," in which an intermediate substance in aqueous solution is reduced by the fuel and circulated over an inert electrode (anode) where it is oxidized, thereby releasing electrons to the electrode. Similarly, an intermediate oxidant is oxidized by oxygen and circulated to the inert cathode where it is reduced by the electrons from the external circuit. Tests have been conducted using coal as the fuel with limited success. Other tests explored the use of carbon monoxide as the fuel.

Whereas the Redox approach provides a large reaction area, many other problems are introduced, chief among them being that of finding suitable intermediate Redox couples, one readily reduced by a conventional fuel and the other readily oxidized by air, which will yield a high cell voltage.

Increased temperature and pressure have been used in some designs to help electrode reaction by improving catalytic action and the diffusion of the gas in the electrode.

The Bacon cell is the most advanced development and the most compact power source based on this approach. Successful electrode reaction is obtained by operation at 200-240C with hydrogen and oxygen at 600-800 psi. Fig. 11 is a schematic section of the cell showing the materials used.

With pure hydrogen the Bacon cell has run as long as 1500 hours, the life of the oxygen electrode being the limiting factor.

Some success has been experienced with high-temperature cells using fuels containing carbon monoxide. One design, using a porous ceramic matrix to retain the molten carbonate electrolyte, has operated more than six months at 650C.

(Continued on page 112)

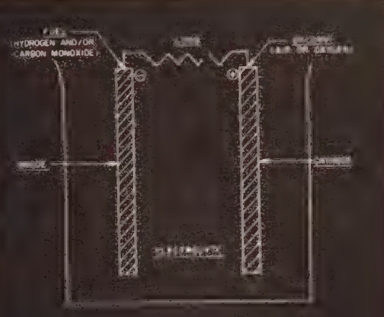


Fig. 8—Schematic representation of a fuel cell.

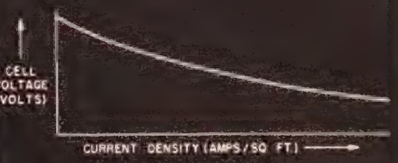


Fig. 9—Typical polarization curve for the fuel cell.

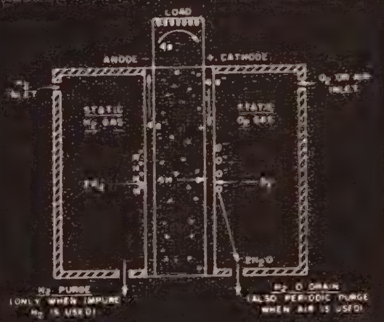


Fig. 10—Schematic section of the ion-exchange membrane cell.

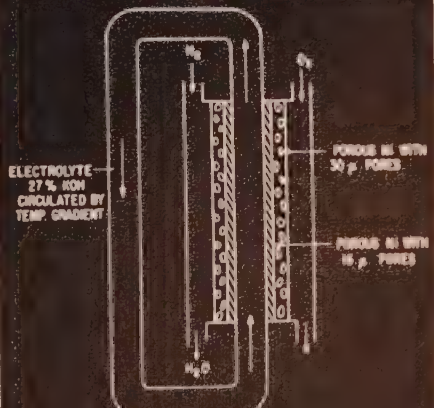

H₂
O₂
ELECTROLYTE 27% KOH CIRCULATED BY TEMP. GRADIENT
POROUS Ni WITH 30 μ PORES
POROUS Ni WITH 16 μ PORES
H₂O

Fig. 11—Schematic section of the Bacon cell showing the materials used.

DETERMINATION OF OPTIMUM

SIZE

The author's method takes into account all known factors and estimates future requirements so that resultant conductor size will not be quickly outgrown and line losses will be within reasonable limits of optimum value.

By R. A. DEWBERRY,
Distribution Engineer,
Montana-Dakota Utilities Co.

THERE has been considerable literature on determining the most economical conductor size to use for any given set of conditions. However, it is the author's opinion that, in general, the available information has not been applied to the best advantage. The reason for this is simply that utility men do not have time to properly apply all the factors that should enter into a cost analysis.

Purpose of this article is to derive a method whereby the optimum conductor size can be determined with a minimum of effort and time-consuming computations.

The annual cost of conductor is made up of three factors,

(a) Annual cost of poles, fixtures, R/W., etc. $= C_1$

(b) Annual cost of energy loss $= C_2/A$

(c) Annual cost of wire in place $= C_3A$

where A = circular mil area of conductor.

Total annual cost $= C_1 + C_2/A + C_3A$ (1)

The first derivative of (1) equated to zero will show that the least annual cost will result when,

$$\frac{d\ \text{Annual cost}}{dA} = -C_2/A^2 + C_3 = 0 \text{ or } C_2/A = C_3A \quad (2)$$

The foregoing is classic but it is not worth much to us if we cannot readily evaluate C_2 and C_3.

Evaluation of C_2. The annual loss in kwh for a uniformly loaded feeder is:

$$\text{Kwh} = (\text{kva}/\sqrt{3}\text{kv})^2 \times 8.76 \times R \times \text{Loss Factor} \quad (3)$$

where R is the total resistance of feeder per conductor.

It has been shown that for the typical feeder the loss factor is:

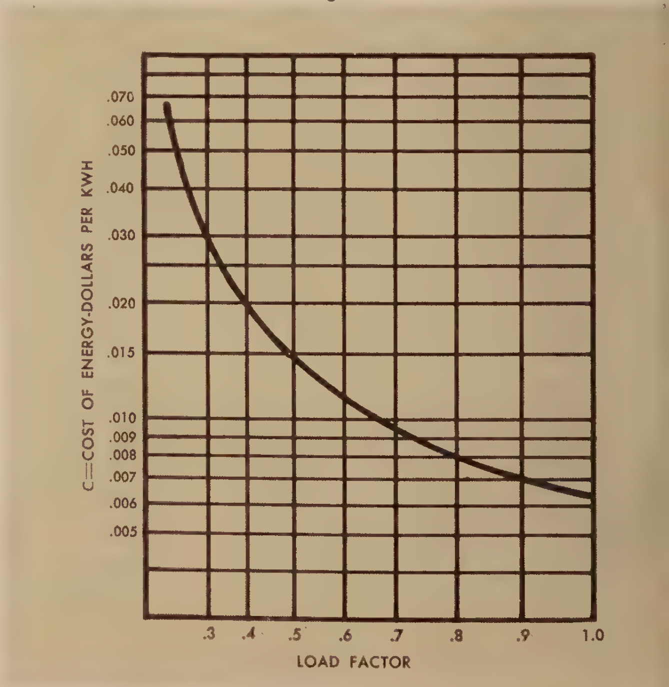
$$\text{Loss Factor} = .7\,(\text{load factor})^2 + .3\,(\text{load factor})^* \quad (4)$$

Since most systems will have a load factor (LF) between .3 and .8 we can simplify (4) by substituting $LF^{1.6}$ for .7 (load factor)^2 + .3 (load factor). This is approximately correct for load factors between .3 and .8.

In equation (3) we may substitute $\rho D/A$ for R where ρ = resistivity of conductor in ohms per mil-mile and D = length of feeder in miles. The average value of ρ for ACSR conductor as shown by wire tables is 93790 ohms per mil-mile.

The Overhead System Distribution Committee** gives a curve relating cost of energy per kwh,c, to the loss factor. Substituting $LF^{1.6}$ for loss factor this curve

Fig. 1



CONDUCTOR

s redrawn as shown in Fig. 1.

Making the substitutions referred to above and aplying c from Fig. 1, we can rewrite (3) and get the ost of kwh loss per year:

Cost of energy loss per year =

$$(kva/\sqrt{3}kv)^2 \frac{93790Dc\,(LF)^{1.6}\,8.76}{A} = C_2/A \qquad (5)$$

Evaluation of C_3. The annual cost of the wire in lace is:

$$\text{Annual cost} = prwD/100 \qquad (6)$$

vhere p = Cost per pound of conductor in place
r = percent interest plus depreciation
w = pounds of conductor per three-phase mile
D = length of feeder in miles

Wire tables give an average value of w for ACSR onductor as w = .00724A per conductor mile. For hree-phase, three-wire w = .0217A and for threehase, four-wire w = .0289A. Substituting these values n (6) we get:

Annual cost of wire in place for three-phase threewire feeder = $prDA \times .0217/100 = C_3A$ (7)

Annual cost of wire in place for three-phase, fourwire feeder = $prDA \times .0289/100 = C_3A$ (8)

Equating (7) to (5) and (8) to (5) as required by (2):

$$(kva/\sqrt{3}kv)^2 \times \frac{93790Dc \times 8.76 \times LF^{1.6}}{A} = \frac{prDA \times .0217}{100} \qquad (9)$$

$$(kva/\sqrt{3}kv)^2 \times \frac{93790Dc \times 8.76 \times LF^{1.6}}{A} = \frac{prDA \times .0289}{100} \qquad (10)$$

and solving for A,

$$A_{3u} = (kva/kv) \times 35400 \times \sqrt{cLF^{1.6}/pr} \qquad (11)$$

$$A_{4u} = (kva/kv) \times 30800 \times \sqrt{cLF^{1.6}/pr} \qquad (12)$$

where the subscripts refer to three-wire and four-wire uniformly-loaded feeders.

For express feeders the loss will be three times as much as for uniformly-loaded feeders. Multiplying (5) by three and equating the results to (7) and (8) as before we obtain,

$$A_{3e} = (kva/kv) \times 61600 \times \sqrt{cLF^{1.6}/pr} \qquad (13)$$

$$A_{4e} = (kva/kv) \times 53300 \times \sqrt{cLF^{1.6}/pr} \qquad (14)$$

where the subscripts refer to three and four-wire express feeders.

Fig. 2 evaluates $\sqrt{cLF^{1.6}/pr}$ for various values of LF,p and r.

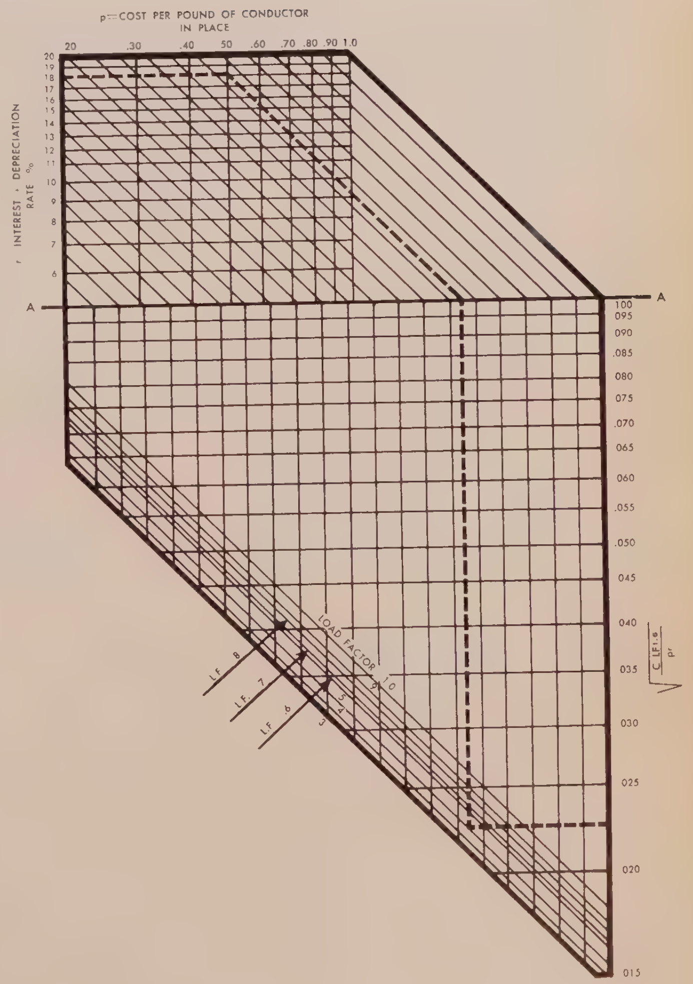


Fig. 2

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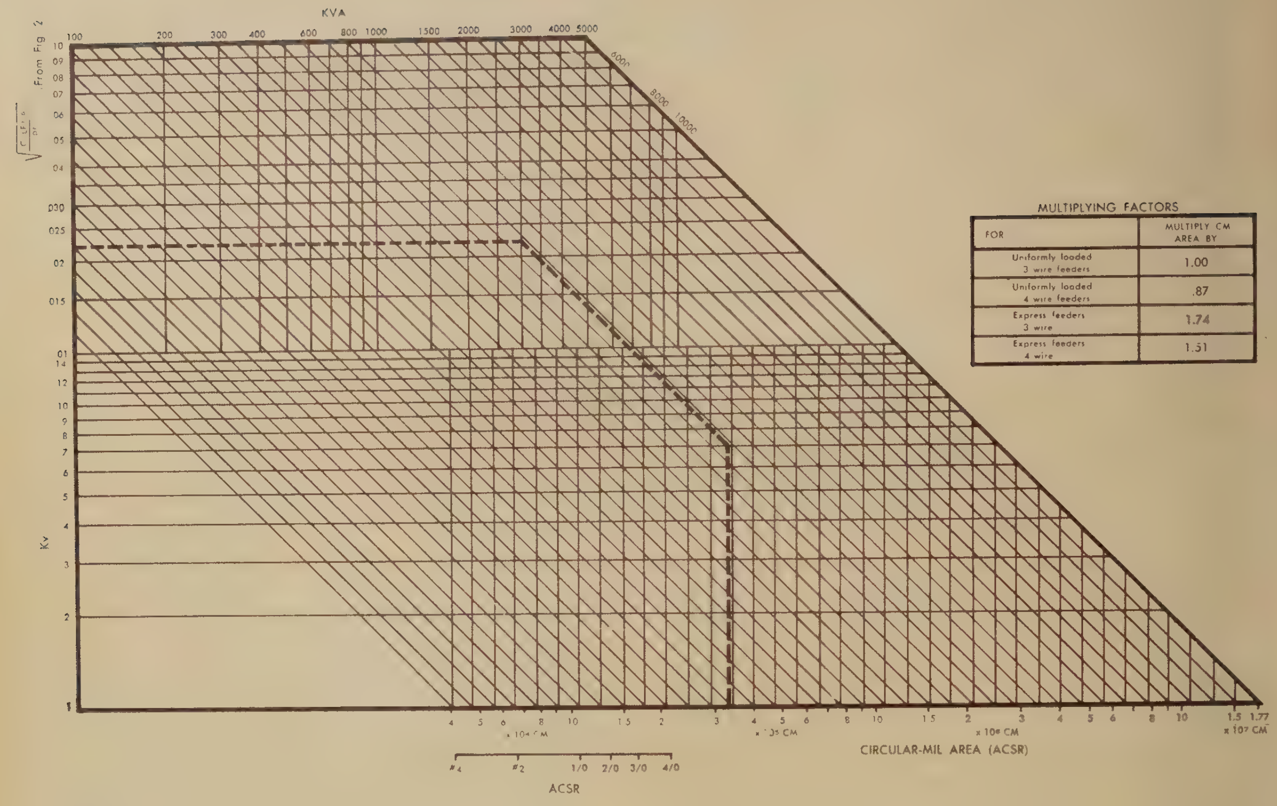
* *Electric Transmission and Distribution* by Bernhardt G. A. Skrotzki, page 406, McGraw Hill Book Co., 1954.

** General Electric Distribution Data Book, page 76, 1957.



MULTIPLYING FACTORS

FOR	MULTIPLY CM AREA BY
Uniformly loaded 3 wire feeders	1.00
Uniformly loaded 4 wire feeders	.87
Express feeders 3 wire	1.74
Express feeders 4 wire	1.51

Fig. 3

Fig. 3 evaluates $\sqrt{cLF^{1.6}/pr} \times (kva/kv) \times 35400 = A_{3u}$, the optimum size conductor for three-wire, uniformly-loaded feeders.

It will be noted from (11), (12), (13) and (14) that

$$A_{4u} = 30800/35400 \times A_{3u} = .87A_{3u} \qquad (15)$$

$$A_{3e} = 61600/35400 \times A_{3u} = 1.74A_{3u} \qquad (16)$$

$$A_{4e} = 53300/35400 \times A_{3u} = 1.51A_{3u} \qquad (17)$$

From this we get the multiplying factors to apply to A_{3u} to arrive at the optimum conductor for four-wire, uniformly-loaded feeders and express feeders both three- and four-wire.

Example. A proposed feeder of 7200 volts, three-wire, is to carry a peak load of 3000 kva. Load will be uniformly distributed along the feeder. What size conductor should be installed if load factor is .5, inplace cost of conductor is $0.50 per pound and interest plus depreciation rate is 18 percent?

Enter Fig. 2 at $r = 18$ and $p = .50$. At their intersection follow diagonal line to line AA then drop vertically to load factor .5. From there project horizontally to the right and read .0225 for $\sqrt{cLF^{1.6}/pr}$.

Enter Fig. 3 with the value .0225 and extend horizontally to kva = 3000. Then follow diagonal to 7.2-kv line and drop vertically to lower scale and read 330,000 circular-mils. The nearest standard size conductor would be 336,000 cm and would be the optimum conductor for the conditions assumed.

It is interesting to note that the sizes of conductors given by this method are, in general, somewhat larger than those existing or being installed in most utilities today. This indicates that our conductors, in general, are too small.

The foregoing is based on the assumption that we know or have available the interest plus depreciation rate as well as the installed cost per pound of conductor. This information is available for the past and present but inasmuch as conductors should be sized for future conditions it becomes somewhat of a guess as to what those factors will be in ten, fifteen or twenty years. However, the trend of these factors are apparent and with that as a guide it is believed that the values of interest plus depreciation, cost per pound of conductor, kva, etc. can be estimated with enough accuracy to allow us to install conductors that will not be outgrown so quickly and at the same time keep line losses within reasonable limits of the optimum value.

lany lessons were learned as a result of the severe snow and wind storm during March 1958. Pole failure was most significant source of trouble.

DISTRIBUTION SYSTEM IMPROVEMENTS REDUCE STORM DAMAGE, EXPEDITE RESTORATION

Iow a drastically revamped and modernized listribution system and restoration procedures an provide better service continuity and facili-ate repairs after storms.

By
A. A. HALL, JR.
Senior Engineer,
Electric Distribution Dept.
Baltimore Gas & Electric Co.

CHANGES in construction and restoration procedures, as a result of a severe snow and windstorm during March 1958, have assured Baltimore Gas and Electric Company that future storms will cause less trouble and that service will be restored more rapidly. Inspection and service restoration procedures during severe emergencies have been drastically revamped and modernized.

Pole failure was the most significant source of trouble and accounted for the bulk of the time required for service restoration. It is significant that 53% of the broken poles were either class 6 or 7 while these classes accounted for only 26% of the poles on the system. Now, the minimum class of pole that we use is class 5 and the great majority are class 4 or larger.

Broken Conductors

Perhaps the next most significant source of trouble was broken conductors. Like many other utilities, we had millions of feet of #4 and #6 copper on the system. Needless to say, these conductors came down in many places due to the excessive snow load. Some years ago because of increasing loads and the rising cost of copper, the minimum size of primary and secondary conductors was increased to #2 ACSR. This conductor also has the advantage of much greater strength than #4 or #6 copper. Approximately half of the primary wire that we install today is #3/0 ACSR. Since the smaller copper conductors are currently being replaced with ACSR in larger sizes, our potential troubles in this area will decrease each year.

A large number of wooden pins were broken off because of unbalanced conductor tensions. We have since changed to the use of steel pins which we fully expect to practically eliminate pin breakage.

We also found that quite a few of the smaller anchor plates pulled out or crept enough so that they were useless. We have since discontinued use of this smaller plate and studies of various anchor designs are continuing.

Aerial and Spacer Cable

Several years ago, we embarked on a large-scale service continuity program which called for increasing the spacing between open-wire conductors, extensive tree trimming and installation of a large amount of pre-assembled and spacer-type aerial cables. All of our so-called "bad actor" feeders were surveyed to determine how their service record could be improved. Where possible, trees were trimmed severely and a great many were cut down. Hundreds of thousands of feet of aerial

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Editor's Note: This article has been adapted from a paper presented at a meeting of the System Planning Committee of the Pennsylvania Electric Association.

cable were installed and the conductors on large portions of the feeders were re-spaced. After this intensive part of the program was completed, routine maintenance trimming kept our tree problems to a minimum.

This program paid off handsomely and the bright spot during the entire storm was the excellent performance of pre-assembled aerial cable and spacer cable. These two types of primary cables withstood tremendous battering from falling trees and limbs but kept working.

Service Restoration

Shortly after the March 1958 snowstorm and even before the entire system was rehabilitated, investigations and studies were begun to determine how, in the future, we may act even more promptly than we had and how we could restore service more rapidly.

Our experience had shown the particular need for a larger, more highly trained inspection group capable of rapidly and thoroughly inspecting the entire system to determine damage.

Changes in construction have already been effected. As system grows, it will be stronger because of these changes. Broken conductors were a major cause of trouble.

We learned that the vast amount of restoration work to be done and the large number of crews working, including Company, contractor and crews from other utilities, made it difficult to coordinate the restoration activities from our central headquarters. Further, our eight District Service Centers had insufficient facilities to handle an emergency restoration force of up to ten times the normal complement of crews. It was apparent that the District Service Center operating territories must be further sub-divided into smaller segments with local headquarters to act as independently as possible in restoring service within their segments.

Reporting Damage

It was pointed up that more effective procedures were required for reporting system damage and restoration progress so as to enable timely requests for assistance from outside companies and to permit our Company Management to accurately inform the press and public of our problems, what we are doing to restore service, and when we expect to restore service.

These three major areas—inspection, decentralization of restoration work, and the reporting of system damage and restoration progress—were given careful attention and form the basis of what, we feel, will afford more rapid and efficient service restoration.

Severe Emergency Plan

When our system is struck by a bad storm—hurricane, snow, or sleet—and the Severe Emergency Plan is put into effect, a great many things begin to happen concurrently.

Our eight District Service Center territories have been sub-divided into a total of 29 work areas with Area Headquarters located in such places as fire departments, American Legion Halls, churches, etc. These Area Headquarters will be the base of operations for construction crews and inspection teams and will house the office personnel associated with all service restoration activities within the area. Telephones, maps, various prepared forms, and other facilities have been provided at each location.

Initial Appraisal Inspection

The first function to be performed after we go into area operation will be the initial appraisal inspection. In order to acquire a system damage appraisal as early as possible following a storm, 100 representative sections, comprising a total area of 100 square miles, of the Company's territory have been selected. Survey crews will patrol these 100 pre-assigned index sections to determine the number of poles down, spans of primary wire down, and the number of service loops down along the route of the primary. Since we know the total number of poles, spans of primary, and loops along the route of the primary in each index section, we can determine the percent damage to each of these components and, by this sampling procedure, estimate the amount of damage in each district and in the whole system.

Now, we know how long it takes to replace or repair the average damaged pole, wire span, and loop so we can calculate the total number of gang hours or gang days required to make repairs. By dividing the required number of gang days by the number of gangs we have, we can closely estimate the total number of days necessary to restore service. By thus obtaining an early, accurate appraisal of the storm damage sustained, we will know how badly we have been hit, how long it will take to restore service with our own crews, and how many (if any) crews we will need from outside.

The initial estimate of the number of customers out of service will be prepared by obtaining load data from power transmission stations operators at attended substations and from operators dispatched to unattended stations during the emergency. As loads on major substations are compiled, they will be interpreted by our Engineering Statistics Department by an analysis of the storm loads and the loads which might be expected during a comparable non-storm period. The ratio of storm load to normal load for the various substations will be applied to the known number of customers served from each substation to obtain an estimate of the number of customers out of service.

The load-data analysis will be sup- emented by specific information om the load dispatcher and the perating Engineering Group con- erning those substations returned service by switching.

Detailed Inspection

Simultaneously with the initial ppraisal inspection, a detailed in- pection will be conducted, so co- rdinated that every overhead eeder will be fully inspected by wo-man inspection teams. Approxi- nately 1000 men have been trained or this purpose. Inspectors will re- ord on feeder maps the locations f damage found, keying these loca- ions to Inspection Repair Orders hey prepare describing the damage. The maps and repair orders will be ised to develop a detailed status of ach feeder and thereby allocate repair crews. As repairs are made, the tatus of each feeder will be revised o that repair crews may be re- llocated.

The inspection crews will be aug- nented by continued use of helicopter patrols and patrols using the racked-vehicle Weasels to reach locations otherwise inaccessible.

Restoration Work

Now that we have inspected every nook and cranny of the system, how do we go about, in an orderly fashion, putting the pieces back together? Actually, restoration work, particularly on transmission and subtransmission, has been in progress all the while that the inspection has been proceeding.

In general, repairs will be made from the source of supply toward the load. Transmission feeders will be restored first whenever possible, then subtransmission feeders and then the distribution feeders on an individual basis from the substations to the feeder points. After service is restored to individual feeder points, complete restoration will be made on individual feeder mains as units; that is, all primary, bus and loop work will be done at one time as work progresses toward the ends of the mains. In this manner, all customers within the damaged area will be returned to service when the feeder is repaired.

Repairs are made from source of supply *toward* the load. Transmission feeders are restored first whenever possible.

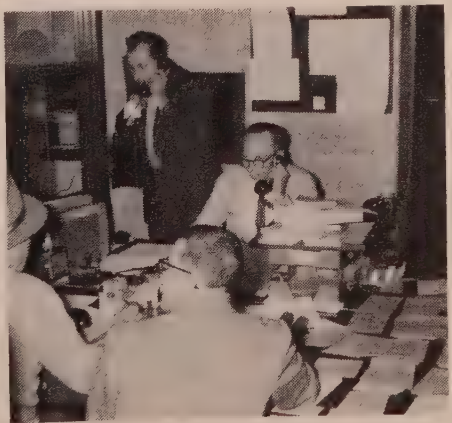
In this general plan of restoration, work on the various classes of feeders may be done concurrently; that is, distribution work may be in progress while transmission repairs are being completed and in areas where no damage has occurred to transmission lines, repairs on distribution lines will be started immediately. Within this framework certain categories of customers and uses, such as iron-lung patients, hospitals, pumping stations, telephone exchanges, etc., will be given priority in the restoration of service.

Rehearsal Develops Refinements

In order to assure ourselves that what we had on paper would work in the field, during August of 1959, 1200 employees from nearly all Company departments participated in a rehearsal of this new Severe Emergency Procedure.

For the rehearsal, it was assumed that five line crews and five service loop crews were working from each area headquarters. Prior to the rehearsal a large quantity of hypothetical damage data was prepared to simulate an actual severe emergency.

During rehearsal of Company's new "Severe Emergency Procedure", Area Headquarters Office personnel use hypothetical damage data as basis to practice analyzing damage, assigning work to crews, estimating number of customers out of service, etc.



During the rehearsal, employees reported directly from their homes to their assigned emergency work locations. The inspectors patrolled distribution feeders and prepared orders to repair hypothetical damage to poles and wires. The Area Headquarters office personnel used hypothetical damage data as a basis to practice analyzing damage, assigning work to crews, estimating the number of customers out of service, ordering the material needed to repair damage, determining restoration progress and estimating dates when service would be restored. The rehearsal developed several refinements for improvement which are being incorporated into the procedure plan.

Smooth-Running Procedure

We now have a large, trained group of inspectors to accurately determine system damage in a much shorter time than perviously possible. By operating in the relatively small area groups, we will be able to eliminate a great deal of confusion while still utilizing a large total restoration force. We believe that the use of the 100 index sections for initial inspection will enable an early, accurate appraisal of system damage while the detailed inspection and the resulting feeder maps and repair orders, properly coordinated, will produce a smooth-running restoration procedure.

UTILITYMAN'S NOTEBOOK

CHAIN HOISTS SPEED UTILITY CHIMNEY ERECTION

By D. S. BAST
Senior Project Engineer
Pennsylvania Power & Light Company

Use of hand hoists in the construction of a giant 450-ft high chimney for the new $46-million Brunner Island Power Plant for Pennsylvania Power & Light near York Haven, Pa., has minimized interruptions to the work and cut construction time.

During construction of the main portion of the chimney, workmen erected new 7½-ft sections every working day. Normally, they would spend the morning hours hoisting the portable steel forms, with the aid and assistance of several hoists on the job site, and place these forms in position for concrete pouring. This concrete was generally poured in the afternoons. By using the forms from the previous day's position, after the concrete was set, the job was finished with a minimum of interruption.

Concrete was prepared in a portable plant nearby and transported to the site in mixing trucks of 5-cu-yd capacities. Then it was dumped into ½-cu-yd buckets inside the chimney and elevated to the pouring crews.

At the top of the vertical lift, the individual bucket was placed on a wooden platform, also supported by these versatile hoists. From the platform, the buckets were elevated above the forms and emptied. Some 1600-cu-yd of concrete were used.

This chimney is 36 ft in diameter at the bottom and tapers to an outside diameter of 24 ft at the top of its 450-ft exposed length. It took a crew of ten workmen some 4½ months to "top off" this concrete bulk which was designed and erected by the M. W. Kellogg Co.

All of the work, including the independent brick lining of the chimney up to a height of 50 ft was completed last Fall. The remainder of the bricking was started early this Spring and will be completec during the latter part of this year

Hand hoists speed construction of huge reinforced concrete chimney. Portable steel forms are hoisted from previous day's position after concrete has set. Hoists also support wooden platform for workmen and concrete buckets. (Photo courtesy of Lancaster NEW ERA and Wright Hoist Division, American Chain & Cable Co., Inc.)

POLE HOLE CORE DRILLERS CONQUER ROCK

Core drillers are solving pole hole digging problems in the rocky subsoil around Tulsa, Oklahoma. Tulsa division of Public Service Company of Oklahoma uses "home-made" core drillers as part of its line department's equipment.

The more solid the rock, the better job the drillers do. Using small steel pellets, smaller than buckshot, for a cutting edge, the driller grinds a deep circle through the rock. The center core is broken loose, wedged to inside of the core drill by wood or a steel bar and lifted out of the hole by the hole digging equipment, itself.

Basically, the core drill is nothing more than a section of steel pipe or casing. An adapter is welded to one end so that it will fit the company's regular drilling equipment. Four angled slots are cut into the othe end of the casing so that the sho will be picked up and rolled ou

Solid rock core taken from Tulsa soil weigh over 600 lbs.

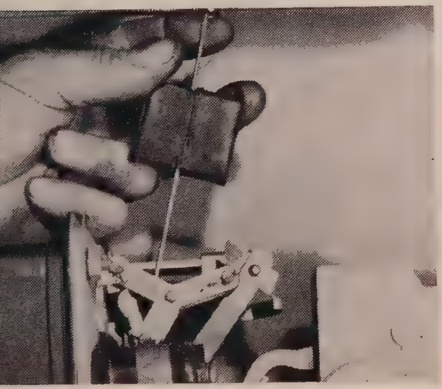
gain as it cuts its way through the ock.

More holes and slots in the top ection of the casing are cut so that he core can be wedged in for lifting and driven out once it reaches he top of the ground.

Years ago, Tulsa division used lynamite to blast out holes. They topped because of hazards involved. Rock holes became a problem then, nd usually had to be chipped out its at a time with an air compresor. By this method, a hole in solid rock would take up to three days to lig.

With the core drills, rock hole ligging time is measured in hours—not days.

Core drill's cutting edge is made up of small shot. Body of the drill is a section of casing or pipe with slots.



MAGNETIC TOOL RETRIEVES PARTS

By A. B. PHILABAUM,
Master Maintenance Man
Ohio Power Co.
Brilliant, Ohio

An adjustable magnetic tool has proved valuable for placing, holding, or retrieving small magnetic parts where standard holding tools are useless. It has been especially useful when working on intricate equipment or inaccessible locations, such as found on relay and PAX units.

Any convenient bar, horseshoe, or alnico magnet can be moved along a formed piece of iron wire or steel rod to vary the magnetic flux at the end. This will gradually release or attract small parts or pieces of hardware. Either the rod or the magnet can be moved and the other held stationary. Rubber tape can be used to keep magnet and rod from becoming separated, so long as clearance is left for sliding.

Devise Linemen's "Mule"

Line work has been facilitated by by a new tool designed by a Carolina Power & Light line crew in Sumter. The crew, headed by H. A. Beckworth recently field-tested the tool on a job that required energized 4/0 bare copper 12-kv primary to be raised five ft and tied in on insulators on a nine-ft arm.

The tool—named "mule" by a lineman who said that all it needed was pair of ears tacked to it—is constructed of four thicknesses of three-quarter-in plywood glued together, and has several hardware fittings from the warehouse scrap bin bolted to it.

The plywood makes a very strong and easily handled gin pole, and being well varnished is also well insulated. It is slipped over the arm and the pin is inserted in the metal brackets under the arm.

Then a dry set of blocks is used to raise the conductor quietly and easily.

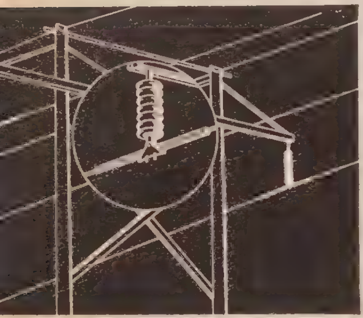
Ready to hoist the "mule" into the air are CP&L crew members Dewitt Geddings (foreground) and Caroll Barker. On the pole are Joe Dunlop (left) and "Sac" Robinson.

"Mule" is handy to hold conductor in the clear while replacing damaged pin insulators.

*Superformed** means better ACCURACY • UNIFORMITY • GRIPPIN

. . . *for* overhead line CONSTRUCTION, PROTECTION, REPAIR,

SUPERFORMING is an exclusive patented process for helical wire forming . . . *developed* by Fanner, the earliest commercial manufacturer of machine-formed armor rods . . . *formed* by special Fanner-designed machines with unequalled accuracy, freedom from surface damage or cross-sectional distortion . . . *tested* with specially-devised equipment simulating most severe operating conditions . . . *backed* by an organization which has built on Integrity, Service and Quality . . . *SAVES MONEY* because application is fast, simple, requires no tools . . . reduces maintenance . . . extends service life of conductors. That's why *more and more utilities are using more and more Superformed Products.* A-1429A

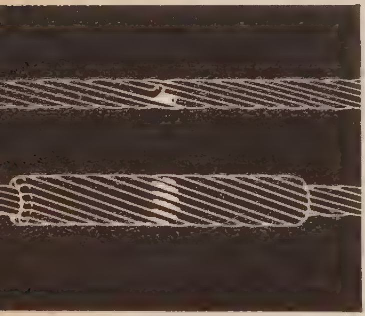


◂ ARMOR RODS

Protect against wind-induced and resonant-frequency conductor vibration at supporting points.

LINEGUARDS ▸

Protect at support points (and taps) in urban distribution where short spans are common; smaller wire sizes and shorter length than Armor Rods.



◂ PATCHRODS

Repair damaged or broken (up to 25% of strands) conductors, too far from support for Armor Rod to protect.

TAP ARMOR ▸

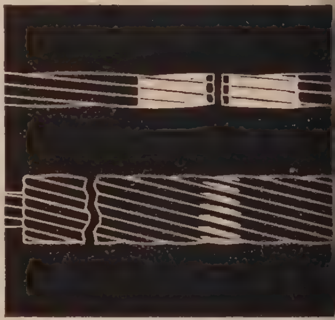
Protects where taps are required beyond extremities of Armor Rods on long spans or un-armored conductors.

◂ FANNGRIPS

Provide ideal dead-ending and splices for wires, strands or cables for: Guys, Conductors, Multiplex Cables, Come Alongs, similar uses.

FANNSPLICES ▸

Join two ends of wire, or restore damaged conductors to original strength.



PLASTIC PRODUCTS FOR CONDUCTOR PROTECTION

Kover-Gard Ground Wire Moldings . . . Plastic Fannguards . . . Rigid and flexible Insulating Tubings.

For field or factory application, wherever there is a real need for surface covering.

STOCKS . . . SERVICE

Fanner Superforms are sold and serviced nationally by 22 Manufacturers' Agents in 34 locations. Stocked by electrical distributors from coast to coast.

PACKAGING

Superformed Products go to you in pre-packaged sets . . . the correct number of rods, centermarked with identification. Also supplied in bulk.

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Fine Fanner
Superformed Products

THE FANNER MANUFACTURING CO.
Brookside Park • Cleveland 9, Ohio
Electrical Products Division

Licensed for use under or made in accordance with one or more of the following patents: Patent No. 2,587,521, 2,769,478, 2,588,663—Other patents pending.

APPLICATION DATA

Specification and ordering are made easy by Fanner Superformed Products Catalog EP-8. Contains 48 pages of Selection, Application, Installation information.

MANUFACTURERS/PRODUCTS

Schedule First Prodac System Installation

When the 342,000-kw Unit 5 of Public Service Electric and Gas Co.'s Sewaren Generating Station goes on the line early in 1962, it will be controlled by the first central station installation of the Prodac digital computer system designed by Westinghouse.

Installation of the new control system is scheduled to begin late next year.

The computer will have the ability to start, operate and shut down the boiler turbine-generator, and plant auxiliaries in accord with pre-established programs for both normal and abnormal conditions. Operating programs will be read into the computer control from punched tape, stored for use as needed in a memory unit, and executed according to computations based on process data received from hundreds of sensing points throughout the plant.

The computer will be built to accommodate as many as 1500 input signals from the station's instrumentation and control points. About one-third will involve binary signals corresponding to contact closures, with the balance being divided among high-level analog signals, and counter pulses. The computer will employ solid state components exclusively except for the mercury-wetted relays used to switch inputs and outputs.

Major equipment to be controlled by the system will be a universal pressure boiler built by Babcock and Wilcox and a cross-compound steam turbine driving two 208,000-kva inner-cooled generators. Designed by Westinghouse, the turbine-generator equipment will provide a number of special sensing devices and control operators for

(Continued on next page)

Early Forecast for 1961

Optimistic Stability, No Records: A-C's Schweers

The prospect for 1961 is that it should be a stable year, according to C. W. Schweers, vice president, Allis-Chalmers Mfg. Co. Speaking at the Eighth Annual Marketing Conference of the National Industrial Conference Board in New York last month, Mr. Schweers predicted that the year will provide enough activity to keep industry and business busy, but cautioned that real effort will be required, and that business should be conducted in a conservative manner.

Specifically, Mr. Schweers stated that he anticipated utility growth to continue, but that improvements in efficiency and higher ratings for equipment may affect the market. He anticipates generating and distribution equipment bookings to be down slightly next year, while transmission equipment bookings will be up considerably.

In discussing the general picture from the point of view of a machinery and equipment manufacturer, Mr. Schweers said he could "see a number of favorable pluses in 1961. Among these are the probability of some easement in the money and credit situation, upgrading of plants for greater productivity to meet competition at home and abroad, probability of new products from the extensive research and development carried on in most industries.

Negative aspects are surplus capacity in most industry, foreign competition and lower prices (coupled with the resultant lower profits), and the expansion of many manufacturers in foreign market areas.

Specific observations from the equipment industry point of view indicate the following:

- Construction—Road program to pick up, market as good as '59 and '60, probably better. Other construction looks stable.
- Mining—Plans and activity in developing new sources of ore. Cement industry affected by shifting population, new plants planned, modernization to reduce production costs also important. In general, activity up somewhat.
- Iron and Steel—Improvements and mill modernizations scheduled. Year looks good.
- Non-ferrous metals—Surplus capacity should be reduced. Capital expenditures about the same as this year.
- Chemical and Petroleum—Expansion historically is on cyclical basis. Prospect for 1961 is an increase in capital expenditures for equipment, somewhat dependent on what happens internationally.
- Paper industry—New products, processes and markets. Capital expenditures should be up.
- Rubber industry—Growing. Year should be good.

Crapo
GALVANIZED

STEEL STRAND

Checked and Double-Checked by Laboratory Technicians

Every coil of wire used in the manufacture of *Crapo* Galvanized Steel Strand is tested and approved by trained laboratory technicians. Samples from both ends of each individual coil are subjected to a series of prescribed tests before stranding. Then, the finished strand is re-checked to make certain that it conforms in every respect to established specifications and our own high quality standards.

Thus you know when you specify *Crapo* Galvanized Strand that every precaution has been taken to assure maximum performance in the finished product.

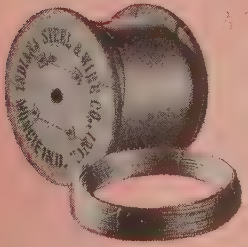
Write for Free Booklet

"The Story Behind **Crapo** Galvanized Wire and Strand" illustrating and describing manufacturing techniques and testing procedures. Ask for Booklet B-59!

AVAILABLE IN 3 COATING WEIGHTS

FOR GUYS, MESSENGER AND OVERHEAD-GROUND WIRE

Crapo Steel Strand is available in all standard sizes and grades and in Class A, B and C galvanized coatings. Class B coating is twice as heavy as Class A coating; Class C coating is three times as heavy.



INDIANA STEEL & WIRE CO., INC.
Muncie, Indiana

*Determines ductility of wire and adherent quality of galvanizing.

Prodac . . . from p. 99

automatic operation. These special provisions include a wide speed range electric starting governor, automatic synchronizing system, and automatic turning gear control.

Steel Exec Predicts Greater Power Use in Steelmaking

"Future growth in steelmaking processes will be in areas that will favor heavily the electric power industry," Edward J. Hanley, president of Allegheny Ludlum Steel Corporation, told a recent General Electric management audience in Schenectady.

Mr. Hanley was the fifth speaker of a series of programs on "What's Behind The Growth in Electric Utilities" and told his audience how changes in electrical technology have changed the steel industry, and vice versa.

"Two of the basic elements in America's industrial progress are steel and power," Mr. Hanley said, "and these two above almost any others are responsible for the kind of society that flourishes in the United States today."

Forecasting a bright future in steel, and in industry generally, for electric power, Mr. Hanley told his audience:

"Steel technology and electric power production have moved ahead side by side. The vastly stepped-up use of electric power in steel plants has resulted from three principal developments:

"1–Changes and improvements in the steel-making processes.

"2–Increased productivity of existing and improved quality of products.

"3–Availability of electric power from private utility sources adequate for steel plant operations, supplied reliably, and at competitive prices."

Citing the growth of the electric furnace and the basic oxygen steelmaking processes, Mr. Hanley said that "the electric furnace now accounts for nearly 10% of the 1960 capacity of the entire steel industry and basic oxygen for nearly 3%. Electric furnace capacity will grow steadily and basic oxygen is due for spectacular growth in the next decade.

"Many utility company officials are looking toward the auxiliary equipment connected with the Basic Oxygen steelmaking process as the next major large-scale user of electric power in the steel industry," Mr. Hanley said. He said that power consumption per ton of oxygen produced is 650 to 700 kilowatt hours.

"I think it can be safely said," he continued, "that in view of the economies found in the Basic Oxygen process, the last big open hearth shop has been built in the American steel industry."

Mr. Hanley told about the large transformer capacities for the 200-ton electric furnaces, the vast amounts of power needed for the huge new rolling mills that are being installed in the steel industry, and the growth of consumable electrode vacuum melting—all processes dependent heavily on electric power. He pointed to the progress made in control mechanisms and the role of the electric manufacturing companies in that field.

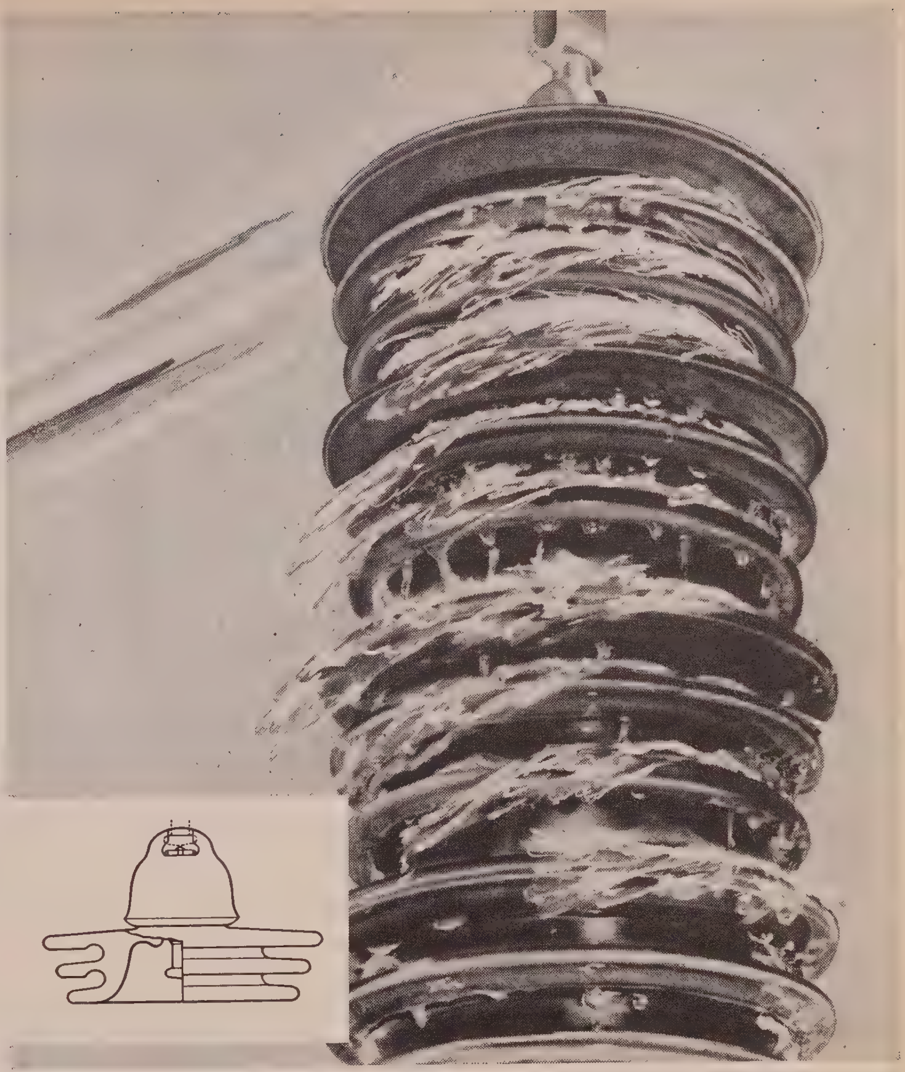
He said that power use in the steel industry went up from an annual consumption of 24½ billion kilowatt hours to almost 36 billions—an increase of 50%—since 1950.

First Thermionic Converter Goes on Market

Practical, sealed-off thermionic converters are now being turned out in productive quantities by General Electric and are scheduled to be on the market this month. Dr. A. O. Jensen, research engineer, revealed that the company's power tube plant in Schenectady is manufacturing the converters in a pilot line operation with a capacity of 60 per week.

The devices produce one watt apiece. Each converter is about the size of a silver dollar and weighs three oz. According to K. E. Wilson, who heads the marketing program, vapor thermionic converters with higher power outputs are scheduled to be produced and marketed at a later date.

Major significance of the announcement is that the difficult transition has been made from ideal laboratory conditions to conditions of the production line.



Delta-Star Fog-type insulators can be cleaned from one side, cutting maintenance costs

The unique undercut in the petticoats of the Delta-Star "Fog-Type" Insulators causes the water to swirl completely around the unit. This means that cleaning can be accomplished quickly and easily by squirting from *one side only*, cutting maintenance costs substantially. In addition, the Delta-Star insulator contour promotes natural cleaning by rain.

Wherever fog or industrial contamination is a serious problem, Delta-Star "Fog-Type" Insulators are the answer to increasing flash-over values. Leakage distance is 50% greater than that of conventional insulators, and *effective leakage distance* is also increased by the greater freedom from conductive contamination.

Delta-Star "Fog-Type" Insulators are available in either ball and socket or clevis and pin types. For complete information on these maintenance saving insulators, write *Delta-Star Electric Division, H. K. Porter Company, Inc., 2437 W. Fulton Street, Chicago 12, Illinois.*

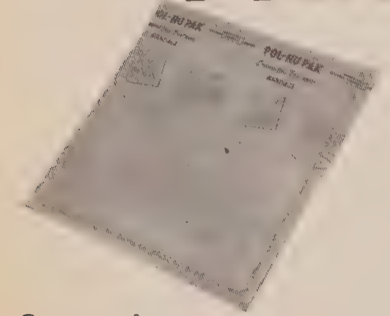
DELTA-STAR PORTER **ELECTRIC DIVISION**

H. K. PORTER COMPANY, INC.

PORTER SERVES INDUSTRY with steel, rubber and friction products, asbestos textiles, high voltage electrical equipment, electrical wire and cable, wiring systems, motors, fans, blowers, specialty alloys, paints, refractories, tools, forgings and pipe fittings, roll formings and stampings, wire rope and strand.

CHAPMAN®

POL-NU PAK



Convenient, envelope-type ground-line treatment bandage

Now line crews can apply ground-line preservative treatments to poles when they do overhead work by carrying Chapman Pol-Nu Paks on service trucks as standard equipment. This convenient pole preservative bandage, available in several sizes, comes as a completely sealed envelope which is easily opened and wrapped around the pole. Chapman Pol-Nu, grease-type pentachlorophenol compound inside the bandage, protects the critical ground-line area from decay and insures longer pole life. Mail the coupon for complete information on Pol-Nu Paks and on Pol-Nu in bulk for use with the Pol-Nu Bandage-Maker when many poles are to be treated.

Slit Pol-Nu Pak on three sides and open to expose the preservative.

Wrap the bandage around pole at ground-line and back-fill.

CHAPMAN CHEMICAL COMPANY

Leading manufacturer of wood preservatives

Memphis 1, Tenn.

Palo Alto, Cal. • Portland, Ore. • Minneapolis
Charlotte, N. C.

Mail coupon for complete data

Chapman Chemical Company
P. O. Box 138, Memphis 1, Tenn.
Please send data on Pol-Nu Pak and information on extending pole life to:

Name____________________

Company____________________

Address____________________

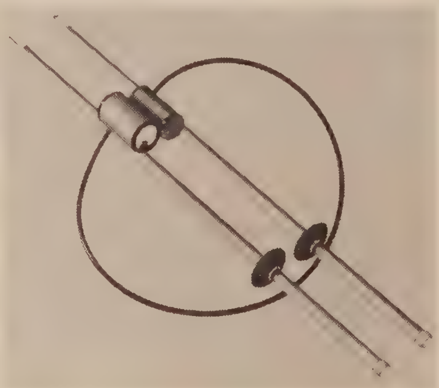
____

NEW PRODUCT DESIGN

Lightweight 50- and 100-KVAR Capacitors

Power capacitors by **Sangamo Electric Co.** have been reduced in weight and size. Reductions of 18 to 25 percent have been achieved in the 5- and 8.67-kv 50-kvar units. New low-loss kraft paper dielectric combined with Sangamo Diaclor has produced a unit with 15-percent lower watts losses over an extended temperature range. Case dimensions of 5-kv unit are 4⅛ in. wide by 13½ in. long by 23⅛ in. high. Narrow case design provides maximum internal heat dissipation for long life and dependability. The 100-kvar units come in a case only slightly larger than previous 50-kvar units. The 100-kvar unit is from 14 to 19 percent smaller. The 5-kv unit weighs 158 lb and its dimensions are 5⅛ in. wide by 20 in. long by 23⅛ in. high. It features a low-loss characteristic. Distance between mounting holes is 22⅝ in. Standard cases for both units are stainless steel.

Circle item #22 on reply card



Hot Voltmeter

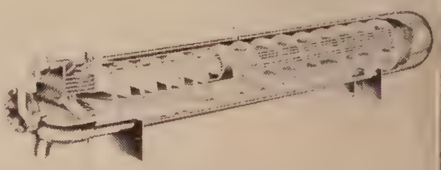
Bodendieck Tool Co. has introduced a meter to check actual voltages in substations and on transmission lines, eliminating possible accidents from application of safety grounds to supposedly de-energized equipment. Unit also assists in proper phasing and in checking voltage drop. Unit is tested for 34.5 kv and below. Meter is calibrated carefully to indicate RMS 60 cps sinusoidal kilovolts.

Circle item #23 on reply card

Feedwater Heaters

A feedwater heater design with a hemispherical inlet chamber and a new type joint between tubes and the tube sheet is available from **Westinghouse Electric Corp.** New design minimizes thermal stresses by using nickel and nickel-copper cladding on the tube sheet, and welding tubes to the cladding, joints which are metallurgically compatible result. Technique was developed for nuclear steam generator construction.

Circle item #24 on reply card



Pompous?

OH, NO SIR! PROUD!

Proud to be associated with New York's new, elegant Dryden-East. The decor is discreetly lavish. Rooms are extraordinarily large, luxuriously appointed.

Naturally, every room has individually controlled air conditioning, color television, FM radio, extension phone in bathroom, its own private cocktail bar. And may I venture to say, sir, the personalized service is unparalleled.

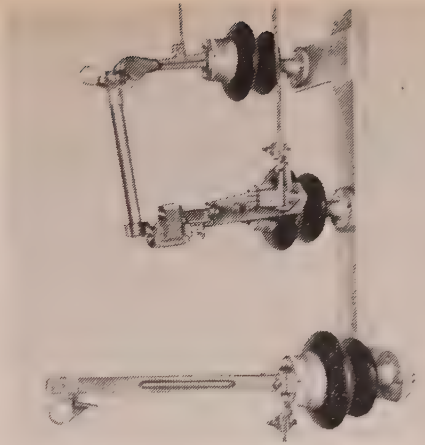
Welcome, sir—and madame—to

New
DRYDEN-EAST
Hotel
39th Street, just East of
Lexington Ave., New York 16

Tariff from $15 to $60 daily.

Several executive suites suitable for large companies as a year round city apartment.

Robert Sarason, *General Manager*



Combination Disconnect, Fuse

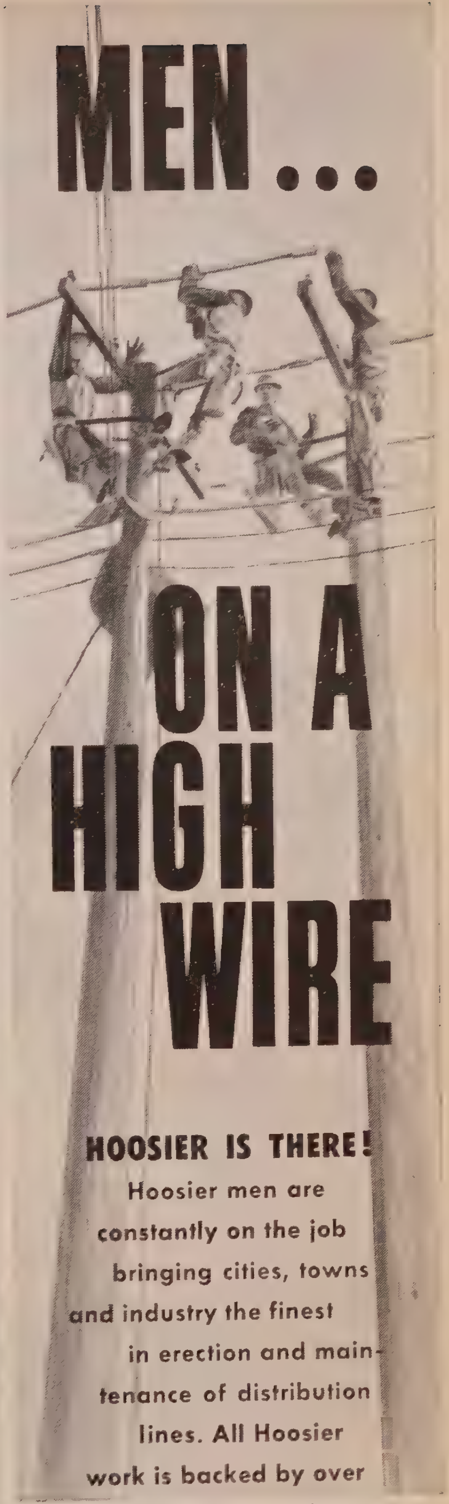
The **A. B. Chance** Type BLP OCR By-Pass Switch combines a by-pass and a power fuse into one unit for greater convenience in isolating oil circuit reclosers for inspection and maintenance. Available with the fuse either mounted to the right or left of the center base of the switch, providing flexibility of arrangement on the structure. Available in ratings 7.5, 15, and 23 kv, 100 and 200 amps fuse ratings, 200 amps continuous.

Circle item #25 on reply card

Impulse Generator

A high-accuracy system to generate impulses for the operation of demand meters, totalizing relays, and data counting and printing is offered by **General Electric.** Type D-41 impulse generator is applicable to large customer billing, tie line metering between utilities, generation, load survey and kw demand load control systems. The device may be used where conditions of oscillation or float of in-out power occur with no impairment of accuracy.

Circle item #26 on reply card



HOOSIER IS THERE!

Hoosier men are constantly on the job bringing cities, towns and industry the finest in erection and maintenance of distribution lines. All Hoosier work is backed by over 40 years of continuous, dependable service to the electrical industry and its consumers.

HOOSIER
ENGINEERING CO.
1350 HOLLY AVE. • COLUMBUS 8, OHIO

TECHNICAL BRIEF NO. 60-2

By D. L. Davies, *Manager, Technical Dept.*
Wood Preserving Division
Koppers Company, Inc.

PRESERVATIVE PENETRATION IN SOUTHERN PINE POLES

Emphasis in the past has been placed on the importance of preservative retention in poles. Penetration is equally important. The data on which present AWPA penetration requirements are based are reviewed below.

INITIAL SPECIFICATIONS

In 1924, the American Wood-Preservers' Association adopted its first specification covering pressure treatment of poles. This specification required that "all of the sapwood and as much of the heartwood as practicable" be penetrated. The method for determining penetration was not clearly defined.

RELATIONSHIP BETWEEN PRESERVATIVE PENETRATION AND DECAY

In the early 1930's AWPA Committee 5-5-1, "Poles-Pressure-Treatment" began an extensive inspection of pole lines to determine whether there actually was any relationship between preservative penetration and decay. The investigation included a careful examination of 2,393 southern pine poles which had been in line ten years or less.

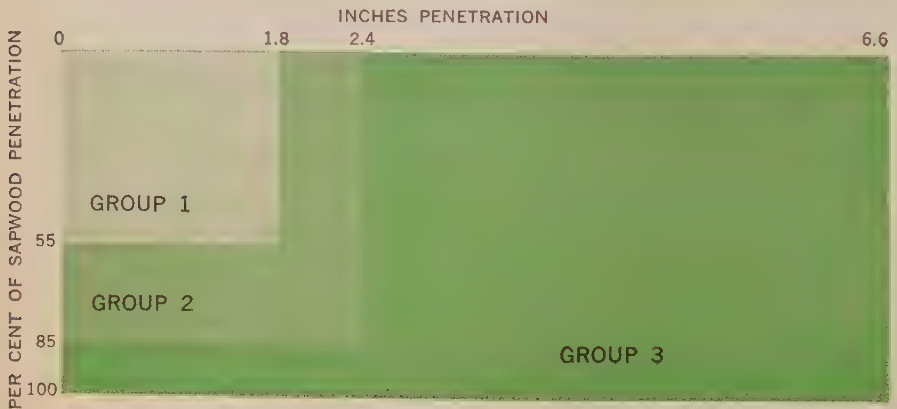
Sections of the chosen lines contained from 100 to 200 or more poles that had been set consecutively in a period of one year.

Each pole was tested by sounding with a hammer or a hatchet. When hammer blows produced a dull tone, the suspicious area was sampled with an increment borer, so that sapwood depth, penetration, and decay could be determined in that area. On all poles which proved sound, increment borer cores were taken 4½ feet above the ground line for measurement of sapwood depth and penetration.

TEST RESULTS

Table below shows that there were *no* failures in Southern Pine Poles with at least 2½ inches of penetration *or* 85% or more of the sapwood penetrated.

As a result of this study, the AWPA, in 1937, revised the standard for southern pine poles to require a minimum penetration of either 2½ inches or 85% of the sapwood.



▢ **GROUP 1**—(286 poles tested) 223 contained no internal sapwood decay, 28 contained internal sapwood decay, but were serviceable and 35 failed due to internal sapwood decay.

🟩 **GROUP 2**—(324 poles tested) 318 contained no internal sapwood decay, 5 contained internal sapwood decay but were serviceable, and only 1 failed.

🟩 **GROUP 3**—(1783 poles tested) no internal sapwood decay.

KOPPERS
PRESSURE-TREATED WOOD

For the full report on Preservative Penetration in Southern Pine Poles, or answers to technical questions on poles or pole treatment, write: Koppers Company, Inc., Wood Preserving Division, Technical Department, Room 742, Koppers Building, Pittsburgh 19, Pa.

C-46

Hydraulic Hammer

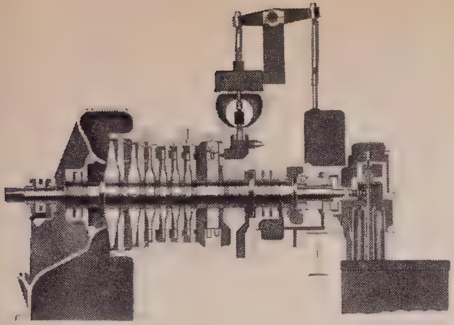
A portable hammer that speeds up backhoe or loader operations by cutting needless delays caused by hard-pan clay, rock formations, concrete, or frozen ground has been introduced by **Henry Mfg. Co.** The special hollow type drill tool easily penetrates to a depth of 24 in., with air pressure created by the striker used to clean chips from the drill hole. Operates on any 10 gpm hydraulic system or above.

Circle item #27 on reply card

Lineman Protection

An Epoxyglas®-insulated barrier, which protects linemen from backing into energized conductors while working the cold side of the pole, has been introduced by **A. B. Chance Co.** The Safety Line Barrier clamps on the crossarm of double circuit, three-phase, single pole structures and serves as a guard to the lineman in maintaining a safe working clearance from the hot side. Bright orange color also acts as a visual barrier.

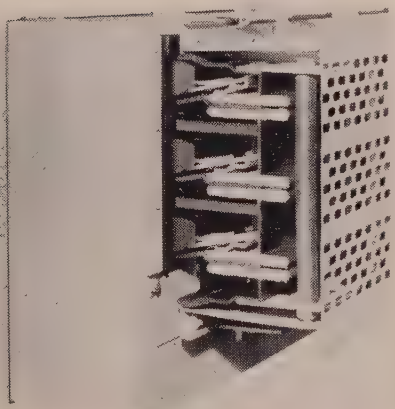
Circle item #28 on reply card



High Speed, Small Turbines

The line of small turbines manufactured by **Westinghouse** has been extended to include high-speed multistage units. Available in five frame sizes, the new units are rated to 32,000 hp and 16,000 rpm. Designed for 1500 psig and 950F steam conditions, the units can be adapted for 2400 psig, 1050F applications. Exhaust pressures can be as one in. mercury. Any number of stages can be used.

Circle item #29 on reply card



Introduce Hair-Pin Stab

An exclusive inverted hairpin design is the feature of a stab introduced by **Federal Pacific Electric Co.** for use with take-off devices in low-impedance plug-in bus duct. Unit actually exerts more than normal pressure when carrying heavy inrush or short circuit currents. Rated 400 amps continuous, the stab will remain in contact with the bus even when short circuit currents exceed 35,000 amps. Requires little maintenance.

Circle item #30 on reply card

A-W hydraulic crane holds gas pipe accurately in place while workman in trench connects joint.

AUSTIN-WESTERN HYDRAULIC CRANE—

Fast, safe way to lay pipe!

Baltimore Gas and Electric Co. operators say, "Even 90-ft. lengths of 16-in. pipe can be handled with precision, and in complete safety to men and equipment, by our Austin-Western hydraulic crane.

Most useful equipment

"It is the most useful piece of lifting equipment ever assigned to our construction crews. It loads and unloads pipe and strings it along construction routes. The A-W's telescoping boom holds pipe for welding, then accurately positions it in the trench until the joint is connected."

They also report that the Model 210's all-wheel drive and steer permit it to work over varied terrain. It climbs embankments, crosses creek beds, or maneuvers in-and-around, up-and-over obstacles which would otherwise slow construction progress.

A-W cranes will lift and tote lengths of pipe or pole like jack-straws; lift and help install transformers, pumps and valves or handle heavy reels of line and cable. The A-W's have virtually unlimited applications in power, gas or water company operations. Ask us for the figures on actual dollar savings being made by A-W cranes for leading utility companies across the U.S.!

5 models available

There's an A-W crane just right for your lift, carry or place requirements. Available in five models with capacity ranges from 3 to 11 tons; self-propelled, truck or stationary mountings. Write today or see your nearest Austin-Western distributor for more information.

Easy-to-attach ⅜-yd. clamshell digs manholes, straightens trench walls, and removes spoil for B.G.&E.

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CONSTRUCTION EQUIPMENT DIVISION, AURORA, ILL.
BALDWIN · LIMA · HAMILTON
BALDWIN BLH LIMA-HAMILTON

Power graders • Motor sweepers • Road rollers • Hydraulic cranes

Lumatrol Mark I, Actual Size (NEMA Mounting)

LUMATROL®
MARK I!

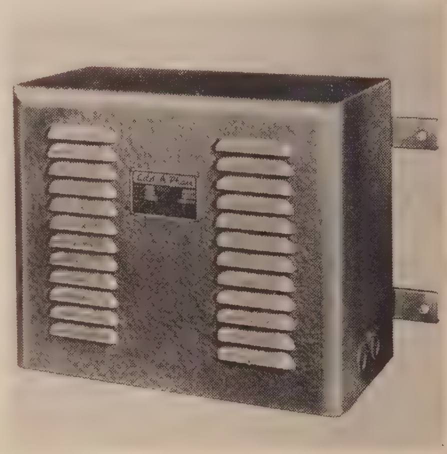
If highest reliability at lowest cost is your most important requirement in automatic street light control... *this is the baby that will do the job!*

Write for Complete Specifications
MICRO BALANCING, INC., Garden City Park, New York
In Canada: J. R. Kearney Corp., Box 270, Guelph, Ontario

Power Converter

Add-A-Phase power converter, designated Type MM, has been announced by **System Analyzer Corp.** Unit permits operation of three-phase electrical equipment from a single-phase line. Unit will produce 100 percent rated hp for all motors connected to it. Panel controls feature separate hp ratings to match each three-phase motor in the system. Multi-motor transformer stations are available in sizes from One to 80 hp.

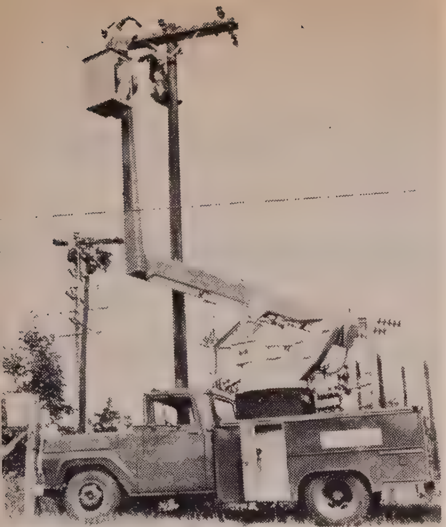
Circle item #31 on reply card



Portable Communication

A wired communication system that provides intelligible communication under any noise condition has been introduced by **Seismograph Service Corp.** It utilizes transistorized amplifiers in combination with a variety of earphone/microphone headsets to form a wearable unit. Amplifier is lightweight and clips to belt. Volume control permits individual setting. For most applications, distance between sets is unlimited.

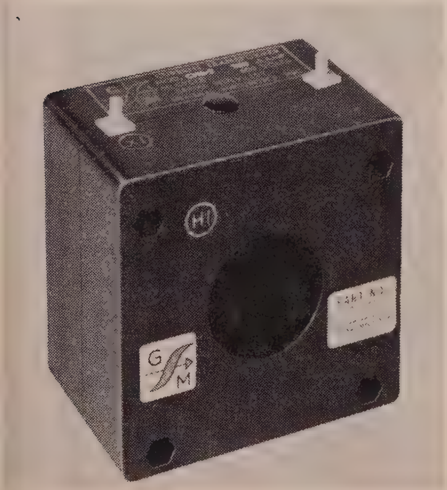
Circle item #32 on reply card



Aerial Lift

No outriggers are required on with the Servi-Lift aerial lift unit made by **Hunt-Pierce Corp.** Mounting can be made on as small as one-ton trucks. Available with either 36 ft or 40 ft working height, canopy mounting leaves deck and compartment space clear. Torsion bar stabilizer provides complete stability for lift operation, even with the truck in motion. Entire structure is built of fibreglass for strength and maximum insulation.

Circle item #33 on reply card



Current Transformers

Design, development and manufacture of 200, 400, and 600 v. current transformers designed for low voltage metering has been announced by **General Magnetics, Inc.** Manufacturer states small size and light weight make them ideal for mounting where they must be supported by the primary conductor. Large center hole permits connection of two #4/0 copper conductors with ease. Both indoor and outdoor types are available.

Circle item #34 on reply card

New Sealed Aluminum Hoist Line means easy lifting in any weather!

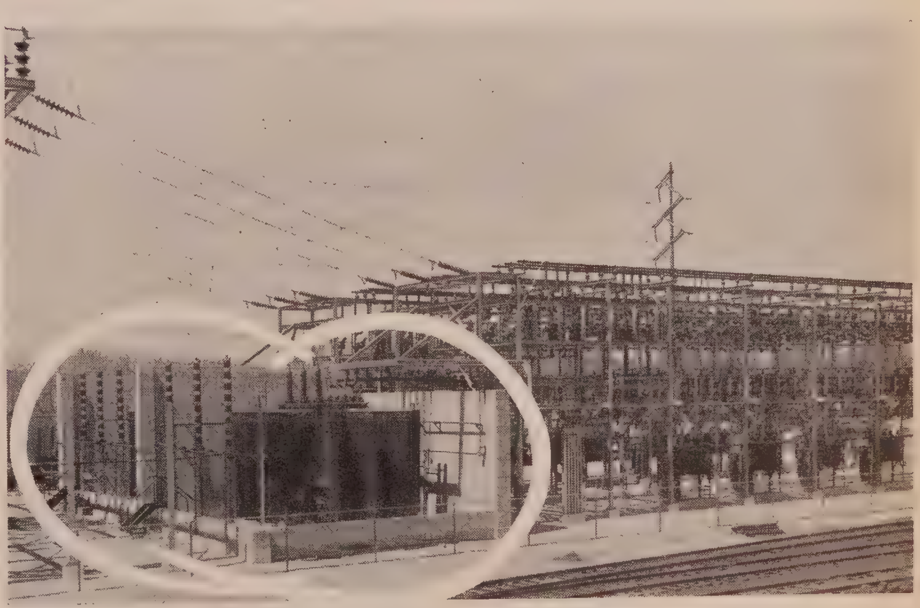
Efficient hoist performance is assured by sealing out moisture, oils, chemicals and dirt from the brake mechanism. Five seals provide permanent protection under exposure conditions.

Lifting is easy with the Coffing Sealed Disk Brake Lever Hoist because the handle pull to lift rated load requires only 57 pounds with the ¾-ton model to 93 pounds with the 6-ton model. Load spotting is precise—to within minute fractions of an inch. Sealed brake will not slip. Six models—¾ to 6-tons.

The high strength aluminum alloy frame is light—makes for easy portability. Ask your distributor or write for Bulletin ADH-78.

MA-15
¾-ton

COFFING HOISTS
DUFF-NORTON
DUFF-NORTON COMPANY
Four Gateway Center • Pittsburgh 22, Pa.



OVER 1,000,000 KVA IN SERVICE

A DELTA GROUNDED TRANSFORMER SAVES SPACE AND MONEY

when both the high voltage and low voltage require a neutral ground

Correspondence invited if you desire additional descriptive matter, have any questions or desire recommendations for a specific problem.

H. L. HOEPPNER

Park Ridge, Ill.
211 Imperial St.

KLEIN
-KORD
NYLON
SAFETY
STRAPS

WITH THESE FEATURES

Klein developed the first fabric safety strap and have pioneered in every development. The recently introduced Klein-Kord Nylon Safety Strap offers these features:

LONGER LIFE—Superior construction, woven from filament nylon. Stretch has been almost eliminated.

PLY ADHESION—The multiple plies of strongly woven pre-dipped nylon are frictionized in neoprene and vulcanized.

FLEXIBILITY—Klein-Kord Nylon Safety Straps are extremely flexible and assure maximum comfort and greater strength. When tested in use, these straps are capable of a test load of 2750 pounds, far in excess of any load they will be called upon to support in service.

QUALITY HARDWARE—All buckles and snaps are drop-forged and tested by Klein in their own forge shop.

WRITE FOR BULLETIN 560

ASK YOUR SUPPLIER
Foreign Distributor:
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Mathias KLEIN & Sons
Established 1857
Chicago, Ill., U.S.A.
INCORPORATED
7200 McCORMICK ROAD, CHICAGO 45, ILL.

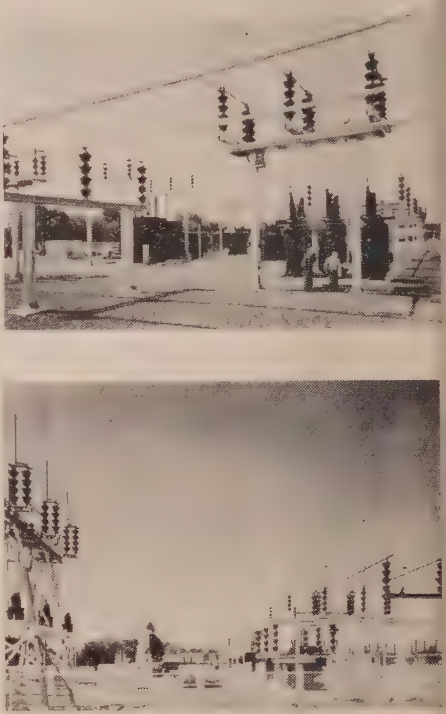
SUPPLY FACILITIES

Alcoa Structural Division Installs First Substation

First all-aluminum substation structure to be supplied by Alcoa's recently formed Structural division has been placed in service by the Philadelphia Electric Co.

The unit, known as the Blue Grass Substation, is one of three such structures to be constructed by Alcoa for Philadelphia Electric.

Located in northeast Philadelphia is rated for 132/13.2 kv. The station, which utilizes a wide-flange aluminum column section, is of low profile pedestal design utilizing over 40,000 lbs of aluminum. It is the tenth station in the Philadelphia Electric system to employ aluminum structures.



Shown at top are high and low level switching buses on aluminum column support at the Blue Grass Substation of the Philadelphia Electric Co. Bottom photo shows the 132 kv take-off at left and the column supports for high and low level switching buses at right.

Automatic System To Aid Insulator Manufacturers

Complete automation of turning operations in the production of porcelain insulators has been accomplished with the application of a two-dimensional tracer system, representing a major breakthrough for the insulator industry. According to the manufacturer, Seneca Falls Machine Co., the productive capacity per man can now be tripled and the quality of the work vastly improved.

The new system is electro-mechanically controlled and will follow any contour around a 360 degree path at a constant cutting speed. The value of the cutting speed can be varied manually or can be controlled automatically.

The manufacturer states that the system is available complete with controls, or the control system alone can be applied to existing equipment.

This partially finished porcelain insulator is typical of the results accomplished with the two dimensional tracer system. Heretofore, porcelain insulators were traditionally shaped by hand held tools. The new system is fully automatic.

ANNOUNCING

PENGO-Prope

—the most satisfactory pulling line available today!

* GREAT STRENGTH
(9,600 lbs. tensile for 3/4" diam.)

* LIGHT WEIGHT
(11.7 lbs. per 100 ft., 3/4" diam.)

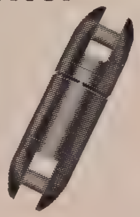
* HANDLES AND SPLICES LIKE MANILA
in any climate or weather.

* WATERPROOF,
(even salt water) can't mildew; excellent dielectric properties.

PENGO-Prope is a synthetic rope of special construction for pulling line use. Although PENGO has other synthetic and manila pulling lines, we believe PENGO-Prope far surpasses these ropes in cost-saving performance.

PENGO-Miller

LINE
STRINGING
SWIVELS



Special models of the well-known MILLER swivels redesigned specifically for tension line stringing use.

The result is a reliable, heavy duty swivel of proper dimensions to pass through stringing sheaves and bullwheel grooves easily, without damage.

PETERSEN
ENGINEERING CO., INC.
Santa Clara, California
Phone: AXminster 6-7712

B-10

O-B Ships Fourth 345-kv Test Pothead

A fourth pothead for terminating 345 kv underground cables has been shipped by Ohio Brass Company for installation at AEIC-EEI Extra High Voltage Research Project, Cornell University.

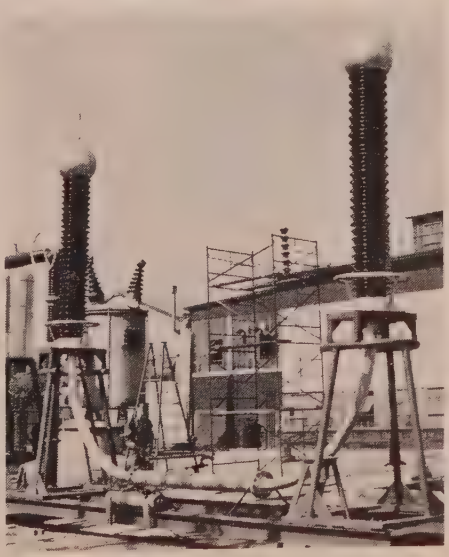
The potheads are of new design and incorporate features that permit one-day installation. Preassembled capacitors utilized for voltage grading and factory-prepared stress cones minimize field installation time.

Capacitors are totally enclosed within the pothead assembly and are never exposed. They remain immersed in the impregnating oil from the time they are vacuum dried at the factory throughout the installation of the pothead in the field.

The stress cone is formed in a paper roll which is wound at the factory. By precise control of wrapping paper and a narrow strip of aluminum foil, a stress cone of ideal shape is included in the lower end. The roll is slipped over the cable and tightened, providing quick and accurate installation of the cone.

Ohio Brass potheads will terminate four of the cable samples at the test site. Two of these will be high-pressure oil, pipe-type cables; one will be high-pressure, self-contained equipped with an aluminum sheath; and one will be low-pressure, oil-filled type construction.

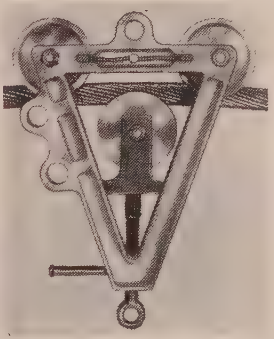
Two of four 345 kv underground test cable terminals with new design features are subjected to preliminary electrical tests in Ohio Brass High Voltage laboratory before shipment to Cornell University.



for Safe WIRE STRINGING

Bashlin's precision built

TRAVELING GROUND



No. 795 Close-up view of the new Bashlin Traveling Ground for Safe Wire Stringing.

Here are features of the Traveling Ground you will recognize as essential for Safe Wire Stringing. 1. Positive ground. 2. Light weight. 3. Eye for hotstick pickup. 4. Bronze oiled bushings. 5. Brush pickup with shunts to common ground. 6. Brass shoulder bolt axle. 7. Adjusts for conductors to and including 795,000 cm. ACSR. 8. All parts replaceable. 9. Shouldered pin to attach ground clamp. 10. Operates in either vertical or horizontal position. 11. Can be installed without threading through. 12. A Heli-Coil thread is used in the frame.

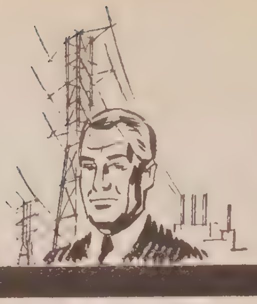
Distributors in Strategic Areas in U.S.A.

Export: Copperweld Steel International Co. In Canada: A. B. Chance Co. of Canada Ltd., Toronto

Write for your copy of supplement to Catalog No. 356 giving complete details.

W. M. BASHLIN CO.
GROVE CITY, PA.

MEN OF POWER



Bechtel Named John Fritz Medal Winner

Stephen D. Bechtel, President of Bechtel Corporation, San Francisco, has been selected as the 1961 recipient of the John Fritz Medal, awarded annually for notable scientific or industrial achievement in the engineering profession, the John Fritz Medal Board of Award has announced.

One of the highest honors bestowed by the engineering profession, the award was established in 1902 to perpetuate the memory of the late John Fritz' achievements in industrial progress. It is sponsored by the American Society of Civil Engineers, American Institute of Mining Engineers, The American Society of Mechanical Engineers, American Institute of Electrical Engineers and the American Institute of Chemical Engineers.

The citation granting the award to Mr. Bechtel reads: "Engineer, builder, industrialist and leader of broad vision in large construction undertakings, nationally and internationally—a pioneer in the creation and development of the modern construction industry, which is unequaled throughout the world and which has made possible the preeminence of our country in time of war and in time of peace."

Mr. Bechtel has been associated with the company which bears his name for 42 years. Under his direction the firm has grown into one of the world's top-ranking engineering and construction organizations. Presently it is responsible for projects at locations spread over a large part of the earth's surface.

Royal Electric Elects Boyce

William H. Boyce has been elected executive vice president of Royal Electric Manufacturing Co., Inc. He will be in charge of the Industries division of the company.

Mr. Boyce came to Royal from Delta-Star Electric division of H. K. Porter Co. He has been responsible for the development of water-cooled fittings, electric furnace cable and bus installations and other high temperature bus applications.

A member of AIEE, Mr. Boyce is a past president of the Chicago Section of American Association of Engineers and has been a director of the Chicago Electrical Association.

Berg B-E Exec. V.P.

Following a recent meeting of its board of directors, Bucyrus-Erie Co. has announced the election of Eugene P. Berg, 47, as executive vice president.

Mr. Berg had previously been employed as general manager of all Chicago operations of the Link-Belt Company, manufacturer of conveyor equipment, and had been with that firm since 1937. As general manager, he was responsible for sales, manufacturing, finance, engineering, industrial relations, and all phases of management.

A 1937 graduate of Purdue University (BS/ME), Berg later received a Masters Degree in Business Administration from the University of Chicago.

MEN OF POWER BRIEFS

UTILITIES

The promotion of **Robert W. Foster** to residential sales manager of the United Illuminating Co. has been announced. He has been with the organization since 1938.

Edward D. Smith has been elected to the board of directors of the Georgia Power Co. He is president of the First National Bank of Atlanta.

Three promotions have been announced by West Penn Power Co.: **Daniel W. C. Molter,** named assistant to the vice president—power; **James E. Davis,** promoted to chief mechanical engineer; and **David E. Gervenak,** appointed superintendent of the Connellsville and Lake Lynn power stations.

The American Society of Mechanical Engineers has conferred the grade of *Fellow* on **Harry J. Bauer,** vice president in charge of production, Consolidated Edison Co.

Southern California Edison has promoted **F. J. Rohring**, a 22-year veteran with the company, to the post of manager of area development.

Corburn D. Hollister, general sales manager, Niagara Mohawk Power Corp., has been elected Bureau Chairman and Chairman of the Executive Committee of Better Light Better Sight Bureau for the two-year term which commenced July 1. He succeeds **W. G. McKie**, general sales manager of Rochester Gas & Electric Corp.

Howard B. Gould, for the past three and a half years manager of Ohio Edison's Alliance division, has been named Youngstown division manager, succeeding **Rufus Moses**, who retired. Succeeding Mr. Gould at Alliance as division manger is **Charles B. Olds.**

Saskatchewan Power Corp. has announced a new organization within its Engineering Group, headed by **W. B. Clipsham**, assistant general manager in charge of engineering and chief engineer; Electrical Design Division, headed by **W. R. Wiggins**, chief electrical design engineer; Generation Design division, headed by **E. R. Smith**, chief generation design engineer; Construction division, headed by **Don J. Anderson**, chief construction engineer.

At the same time, the System Planning department has been raised to the status of a division, under the direction of **W. A. Reed**, chief system planning engineer.

Norman A. Gilchrist, former Bonneville Power Administration Walla Walla district manager and currently operations and maintenance supervisor for the Spokane area office, has been appointed Seattle area manager.

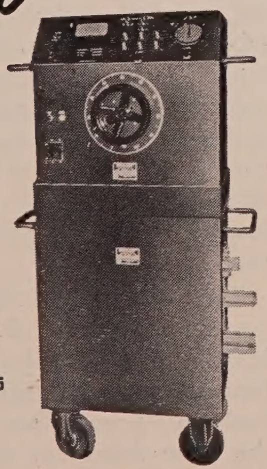
Kansas Power and Light has promoted **Earl Palmberg**, rural and power service manager, to succeed H. S. Hinrichs, as assistant secretary and assistant treasurer. Mr. Hinrichs has retired.

Peter W. Spell has been named manager—industrial sales for Northern States Power.

Correction—R. N. Robertson has been promoted to director of residential development at Florida Power Corp., not Tampa Electric Co., as reported in the September 1, 1960 issue of EL&P.

POSITION VACANT

Power Accountant: Middle East location. Assist Chief Power Accountant to establish, maintain accounting records comparable FPC system, and train local personnel. Knowledge of, and several years of experience with, accounting procedures required, familiarity with electric construction materials and their use, and with utility and plant accounting very desirable. Two-year contract with other benefits. Salary from $13,500 per year based on ability and experience. Address Box 1011, ELECTRIC LIGHT & POWER, 6 No. Michigan Ave., Chicago 2, Ill.


New

CIRCUIT
BREAKER
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MODEL 2075
7.5 Kva

designed for field or shop testing . . . quickly, safely, and accurately by semi-skilled personnel . . .

Ammeter, Timer, Power Source (With High Overload Capacity) Give High-Current (Low-Voltage) Verification of Time Current Curves. Units Compact . . . Portable, continuously adjustable.

Ratings 1 thru 75 kva or Ratings to Meet Your Specific Requirements.

Write today for Bulletin SB-CB-1.

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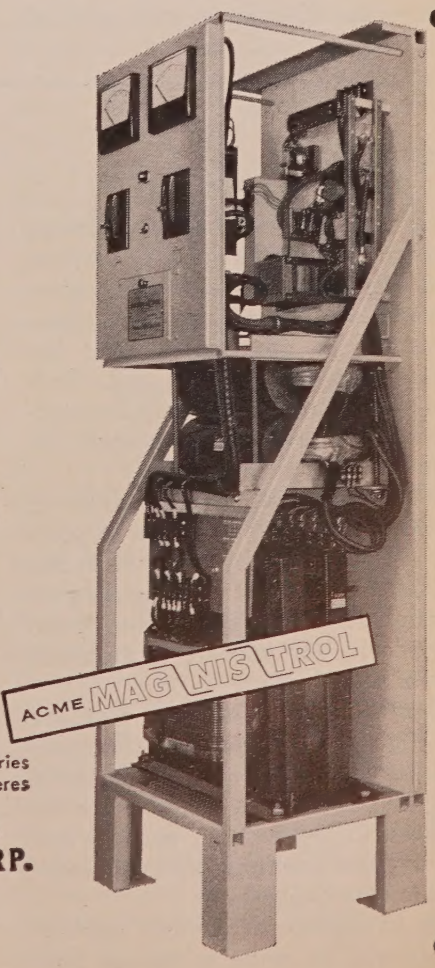
MULTI-AMP ELECTRONIC CORPORATION


A NEW LINE OF FULLY AUTOMATIC SILICON
BATTERY CHARGERS

- NEWEST CIRCUITRY OF PROVEN DESIGN
- COMPLETELY STATIC MAGNETIC AMPLIFIER CIRCUITRY
- ±1% VOLTAGE REGULATION WITH ±10% LINE VARIATION
- REMOVABLE CABINET SHELL
- COMPLETE ACCESSIBILITY TO ALL CONTROLS
- STANDARD UNITS NORMALLY IN STOCK

Standard Units
1, 3, 6, 12 and 25 amperes;
24, 48 and 129 volts
Ask for Bulletin BC-323. Inquiries invited on units up to 300 amperes

Custom Equipment Division
ACME ELECTRIC CORP.
CUBA, NEW YORK
PLANTS IN CUBA, N. Y.
ALLEGANY, N. Y.

MANUFACTURERS

Motorola has named **Robert H. Davis** chief engineer in its microwave department.

A 15-year veteran of National Electric division, H. K. Porter Co., Inc., **H. E. Cole, Jr.**, has been appointed district manager of its Atlanta district.

Federal Pacific Electric Co. has appointed **C. H. Brittenham** manufacturing manager of its Pacific Manufacturing division, the new 250,000 sq ft plant completed last year in Santa Clara.

Southern States Equipment Corp. recently promoted **Roy N. McCowen** to southwest regional manager, and **Bruce Smith** to the post of district manager out of the company's Dallas (Tex.) office.

Also named in Southern States sales department promotions were: **Phillip Williams,** southeast regional manager, covering Florida, Kentucky, Alabama, and portions of Georgia, Louisiana, and Mississippi; **John Howell,** regional manager covering the Carolinas and part of Georgia; and **Thomas Ellison,** regional manager for the Virginias, Tennessee, Pennsylvania, Delaware, Maryland, District of Columbia, and portions of Mississippi and New Jersey.

Appointment of **Jack Steinhauser** as district manager of the company's Texas and New Mexico sales territory has been announced by James R. Kearney Corp. Mr. Steinhauser succeeds **E. C. Dwelle,** who has retired.

General Electric promotions include: **William H. Dennler,** general manager of the Major Appliance division, with headquarters at Appliance Park; **Edmund K. Nock,** manager, marketing, of the Small Steam Turbine department; **Vernon A. Rydbeck,** manager-investor owned utility distribution equipment sales; **Charles B. Seelig,** manager–foreign industrial and utility sales, Medium Steam Turbine, Generator, and Gear department; **Marvin L. Beck,** manager of manufacturing, High Voltage Switchgear department; **W. M. Anthony,** manager of works, utilities, Philadelphia switchgear departments; **Robert H. Smith,** manager-manufacturing, Outdoor Lighting department; **Alfred G. Mellor,** project engineer, Power Plant Engineering Operation.

Electric Power . . .

(Continued from page 65)

Another approach to the design of high-temperature molten carbonate cells is to use gas-diffusion electrodes in free liquid electrolyte. Progress to date encourages the belief that this type of cell offers the possibility of obtaining the electrode current density necessary for a practical fuel cell.

Fuel cells have some promise as an important prime source of power. At present they are still in the laboratory stage of development although it is true that some prototype cells for special applications have been built.

Material and fabrication costs are so high for today's cells that only military services can afford them. Significant break-throughs are required in technology, both in materials and reactions to broaden the fields of application.

It is expected that first applications will be made in special military applications for communication and small ground power. As economics permit, this will be followed by special industrial applications such as fork-lift trucks, emergency communications, process industries, etc. Predictable fuel-cell developments indicate little promise as an economical source of bulk a-c power.

The problems associated with the development of practical, economical fuel cells can be summarized as follows:

1. Obtaining a better understanding of the exact nature of the reactions taking place at the electrode surfaces and specifically the role of the catalyst in these reactions.
2. Discovering or developing combinations of fuels, electrode materials and electrolytes that will result in a fuel cell having a better voltage-current characteristic, i.e. flatter polarization curve.
3. Developing more effective and lower-cost electrode materials.
4. Developing more effective and longer-life membrane materials.
5. Reducing fuel cost by developing lower-cost methods of producing and packing the pure hydrogen needed for hydrox-type fuel cells. Also, methods must be developed for low-cost gasification of hydrocarbons and solid fuels.

Summary

In concluding this discussion of these four unconventional methods of energy conversion to electric power, Table III showing comparative efficiencies of these devices may be of interest.

In considering the Table III efficiencies it must be realized that these efficiencies are either those that have been obtained or might be expected to be obtained under laboratory conditions in laboratory-built devices. Under actual practical commercial operating conditions of a less favorable environment it could not be expected that as high efficiencies could be obtained, at least for any extended period of time.

The efficiency of the first three, i.e. thermoelectric, thermionic and MHD, are basically Carnot-cycle limited while the efficiency of the fuel cell is not. This accounts for the wide difference in thermal efficiencies of the various methods.

For bulk-power electric generation, thermoelectric devices do not seem to be well suited as their present and possible future thermal efficiencies are relatively low and they are not readily adaptable for combinations with conventional thermal cycles. Thermionic converters and magnetohydrodynamics, if successfully developed, will probably be used as topping units to conventional thermal cycles.

This is the basis for showing posible combined-cycle thermal efficiencies in Table III. The com- ined-cycle efficiencies shown hould be compared with present- ay thermal efficiencies of about 8% for the best steam-electric enerating units. Fuel cells have by ar the highest conversion efficiency ut this efficiency is very sensitive o load on the unit and so optimum conomy will depend on a balance eing obtained between power out- ut per unit investment and effi- iency.

In considering the impact of these ew methods on large-scale com- ercial electric power production, t should be pointed out that any ew concept faces extremely severe ompetition in bettering modern ower-generation methods. The nodern steam-electric generating tation has a relatively low installed cost and reasonably high thermal efficiency and can use a variety of, at least at present, low-cost fuels. To compete here, any new method of electric power generation must demonstrate a lower total production cost in mills per kwh and have equal reliability.

The four conversion methods discussed produce d-c power, most of them at very low voltage. Since, except for special applications, our whole power systems are based on a-c, these new methods face the economic disadvantage of the cost of conversion equipment. This will amount to about $40-50 per kilowatt, which is about 30-40% of the total installed cost of a modern steam-electric generating station.

It should also be mentioned that research and development in materials for these new systems will undoubtedly result in the discovery of materials that are applicable to today's conventional steam cycles permitting the economical use of higher temperatures and pressures with resulting higher efficiency and lower power generation costs. Using such new materials in a combined gas turbine-steam turbine cycle plant would result in even greater improvement in efficiencies. The new methods will, therefore, be competing with a moving target and it seems that, except for very special applications, it will be many years before they can supplement conventional cycles in the form of combined cycles in high-fuel-cost areas. It will be even longer before there is any possibility of these new methods generally supplanting future improved conventional methods of generating electric power.

Iow AEP . . .

(Continued from page 59)

rs becomes charged with electrici- y. While a workman is working vithin this field, and if adequate precautions are not taken, he could, oy coming into contact with the ower, receive an electric shock that ould so startle him that he might oe in danger of falling. This could nappen if a man were standing on a dry wooden ladder which was sus- oended from a crossarm when he ascended the ladder and touched the steel.

This hazard is eliminated by the use of aluminum ladders and grounded platforms and by having workmen equipped with shoes having conductive soles. This combination of the metal ladder, grounded platform, and conductive soled shoes eliminates the static charge from the workman's body so that he feels no effect from the charged electric field. Thus, the use of metal ladders and grounded platforms is mandatory at the higher voltages whereas a few years ago at lower voltages, their use was prohibited.

Working Platforms

In the performance of replacing defective suspension insulators in a suspension assembly, working platforms are a convenient aid for pulling and driving the cotter keys and uncoupling the insulators. We, therefore, provide wooden platforms that are attached to the tower at such a point that the workman standing thereon will be within working range of the conductor end of the assembly. Since in this position a man is in the charged electric field, the platform is equipped with copper braid tacked on to the standing surface and bonded with the hardware of the platform so that it is grounded to the tower. In performing this work conductive-soled shoes are also used.

Additional safety precautions must be observed prior to performing 345-kv live-line work. Moisture on hot sticks renders them semiconducting and therefore no live-line work can be done in inclement weather. Weather conditions must be checked not only in the vicinity in which the work is to be done but also in the whole area through which the line extends. A sudden rain or lightning storm could require abandonment of work that is in progress in order to protect the workmen.

Washing Insulators

In addition to live-line work on 345 kv, we are successfully washing and cleaning insulators on voltages up to and including 345 kv with a high-pressure water jet. Safety precautions necessary in such operations are as follows and must not be overlooked. First, the water must have a high resistance, sufficient to minimize electric current leakage into the stream once it is directed against the insulator. Second, the nozzle and all other necessary equipment such as the pumper, pump truck, ladder truck, and tank truck must be securely grounded at all times. Third, the nozzle operators must stay and remain a safe distance away from energized equipment. Fourth, prior to actual washing, a test should be made to determine the resistivity of the water you propose to use. We consider 1200 ohms per cu in. as a minimum resistance for washing energized insulators.

Double Checking Test

To double check this test and to be doubly sure that there is no appreciable current leakage in the stream, a piece of sheet metal 12 in. x 12 in. is mounted at a convenient point on a de-energized bus with a live-line clamp arrangement. Then, the nozzle is placed in a fixed position grounded through a milliammeter. With the stream directed against the plate, the bus is then energized. The leakage current is measured with the milliammeter. If the current in the stream exceeds three milli-amperes, we consider the water too low in resistance and unsuitable for washing energized insulators.

CALENDAR OF EVENTS

October 17-18—Edison Electric Institute, Electrical Systems and Equipment Committee Meeting, Hotel Northampton, Northampton, Mass.

October 20-21—Southeastern Electric Exchange, Engineering and Operating Sections, Shoreham Hotel, Washington, D. C.

October 20-21—Pennsylvania Electric Association, System Operating Committee, Castleton Hotel, New Castle, Pa.

October 20-22—Electric Companies Public Information Program, Second National Youth Conference on the Atom, Museum of Science and Industry, Chicago, Ill.

October 27-28—Pennsylvania Electric Association, Transmission and Distribution Committee, Alexander Hotel, Hagerstown, Md.

November 9-11—American Institute of Electrical Engineers, Second Power Industry Computer Application Conference, Chase Hotel, St. Louis, Mo.

November 14-15—Pacific Coast Electrical Association, Administrative Services Section (Fall Conference), Phoenix, Ariz.

November 14-18—National Electrical Manufacturers Association, Annual Convention, Traymore Hotel, Atlantic City, N. J.

November 15-16—Edison Electric Institute, Area Development Workshop, Park Plaza Hotel, St. Louis, Mo.

November 16-18—Southeastern Electric Exchange, Sales Conference, Henry Grady Hotel, Atlanta, Ga.

November 27-December 2—American Society of Mechanical Engineers, Winter Annual Meeting, Statler Hilton Hotel, New York, N. Y.

January 23-27, 1961—Doble Engineering Conference, Boston, Mass.

January 29-February 3, 1961—American Institute of Electrical Engineers, Winter General Meeting, Statler Hotel, New York, N. Y.

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